BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO AGRICULTURAL, MINERAL AND OTHER INDUSTRIES, WITH SPECIAL REFERENCE TO THE UTILISATION OF THE RAW MATERIALS OF THE DOMINIONS AND THE COLONIES

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PLANT AND ANIMAL PRODUCTS

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion and Colonial Governments

LEMONGRASS OIL FROM TANGANYIKA

By H. E. Coomber, B.Sc., and D. J. Cosgrove, B.Sc., A.R.I.C.

In 1945 the attention of the Imperial Institute was drawn to the fact that a certain firm producing lemongrass oil in Tanganyika was experiencing difficulty owing to the falling off in the citral content of their product. Normally it contained a full 80 per cent. of citral as determined by the bisulphite method, but towards the end of 1944 consignments were produced which, when tested, showed a citral content of only 76 per cent.

With a view to ascertaining the possible cause for this decrease in citral content various samples of oil were examined at the Imperial Institute. These oils had been distilled from grass cut at different times of the year.

The details supplied regarding the five samples examined were :

No. 1. Oil distilled on the 23rd April, 1945, from grass originally planted end 1943—beginning of 1944. Cut from fully matured grass in good condition during the rainy season.

No. 2. Oil distilled on the 18th May, 1945, from grass originally planted April, 1944. Cut from fully matured grass in good condition during the rainy season.

No. 3. Oil distilled on the 22nd January, 1946, from the eleventh cutting of grass originally planted in April 1944. The grass was fully matured and cut in dry weather, distilled after partial drying and gave 4½ kilos. of oil from 1,000 kilos. of grass.

No. 4. Distilled from 15th to 20th June, 1946, from grass

planted April, 1945. Grass cut in dry season. Seventh cutting. Distilled after partial drying. Yield obtained 0·4 per cent.

No. 5. Distilled from 15th to 20th June, 1946, from grass planted March, 1946. Cut in dry season. First cutting. Distilled after partial drying. Yield obtained 0·4 per cent.

Description of Samples

Nos. 1 *and* 2. Slightly turbid oils, having the characteristic odour of lemongrass oils. After filtration through paper the clear oils were yellow in colour.

No. 3. Slightly turbid oil, having the characteristic odour of lemongrass oil. After filtration through paper the clear oil was brownish-yellow in colour and somewhat darker than Nos. 1 and 2.

Nos. 4 *and* 5. Slightly turbid oils, having the characteristic odour of lemongrass oils. After filtration through paper, the clear oils were pale brownish-yellow in colour, both being somewhat lighter than No. 3.

Results of Examination

On examination the five clear, filtered oils were found to have the following constants which are shown in comparison with the ranges of corresponding figures recorded by Gildemeister and Hoffmann (*Die Aetherischen Oele*, 3rd Edn., Vol. 2, p. 321):

	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5	West Indian lemongrass oil (Gildemeister).
Specific Gravity at 15·5° C./15·5° C.	0·8842	0·8811	0·8866	0·8793	0·8805	0·870 to 0·912
Optical Rotation $\alpha_D 20°$ C.	−0·18°	−0·23°	−0·18°	−0·25°	−0·18°	−1° to + 0·2°
Refractive Index $n_D 20°$ C.	1·4860	1·4851	1·4861	1·4840	1·4841	1·482 to 1·489
Aldehydes (bisulphite method), v/v *per cent.*	77·0	79·0	76·0	75·8	74·4	53 to 83
Aldehydes, as citral (hydroxylamine method) w/w *per cent.**	76·0	78·7	75·1	74·6	73·4	—
Solubility in 70 per cent. alcohol at 15·5° C.	Incompletely soluble in 10 vols.	Incompletely soluble in 10 vols.	Insoluble in 10 vols.	Insoluble in 10 vols.	Insoluble in 10 vols.	Usually insoluble
Solubility in 80 per cent. alcohol at 15·5° C.	Soluble with opalescence in 0·9 vols. Turbid with more	Soluble with opalescence in 0·9 vols. Turbid with more	Soluble with opalescence in 0·8 vols. Turbid with more	Incompletely soluble in 10 vols.	Incompletely soluble in 10 vols.	Generally insoluble, but if soluble in 1 vol. the solution usually becomes turbid on further dilution

* *Analyst*, 1934, **59**, 105.

It will be seen from the foregoing results of examination that all the constants of the samples of oil fall within the ranges recorded for West Indian lemongrass oil. The citral content, although approaching the upper limit recorded, is in all cases below the 80 per cent. figure mentioned above.

It will be observed that Sample No. 1, the oil obtained from grass planted at the end of 1943 and beginning of 1944, has an appreciably lower content of citral than Sample No. 2, the oil distilled from grass planted three or four months later, but as the grasses were cut and distilled at different times it cannot be assumed that the difference in composition of the two oils is due entirely to the age of the grass.

Sample No. 3 has a slightly lower citral content than Samples Nos. 1 and 2 and approximates more closely to No. 1 than No. 2 in this and other respects. The producers of the oil state that Sample No. 3 was distilled at the same pressure from grass grown on the same land as Samples Nos. 1 and 2, the only difference in conditions being that the grass was grown in comparatively dry weather and cut after partial drying. As it is known that lemongrass requires much moisture during growth the fact that Sample No. 3 was produced from grass grown in dry weather may account for its lower citral content.

Samples Nos. 4 and 5 are definitely inferior to the other three samples examined as far as aldehyde content is concerned. They have also lower specific gravities and refractive indices, and are inferior as regards solubility in alcohol.

The Imperial Institute has no information regarding the normal time of cutting in Tanganyika, but in other parts of the world where lemongrass is cultivated for its essential oil it would appear that cutting at the beginning of the wet season is the usual practice. The results of examination of the Samples Nos. 4 and 5 indicate that cutting the grass immediately after the rains cannot be recommended.

On the general question of the low citral content of lemongrass oils distilled by this firm in Tanganyika since 1944, which is the main purpose of this series of analyses, it may be that the depression in citral content is brought about by too frequent cutting of the grass. Sample No. 4 was distilled at its seventh cutting taken in approximately 14 months, or an average of six cuttings per year, and the previous Sample No. 3 from grass at its eleventh cutting in approximately 22 months, again an average of six cuttings per year. This rate, according to information at the Imperial Institute, is much in excess of that usually followed, which is three to four per annum according to the rainfall. Again, Sample No. 5 was cut only three months after planting, as compared with the five to nine months adopted in Ceylon. Conditions of soil and climate must, of course, have a great influence on the number of cuttings which are possible each year, but it is open to question whether,

as stated in reference to Sample No. 3, the grass is, in fact, fully mature when cut so frequently as an average of two months per cutting. A number of workers have demonstrated that the distillation of immature grass furnishes an oil which is low in citral.

Another factor affecting the yield and quality of the oil which must not be overlooked is that lemongrass rapidly exhausts the soil; for this reason the grass should be transplanted every three years or so.

The method of distillation, too, must be rigidly controlled. In this connection it has been stated that higher pressures of steam (of the order of 20 lb. per sq. in.) increase the yield of oil but decrease its citral content in comparison with distillation carried out with steam at lower pressures of about 10 lb. per sq. in.

According to the information supplied, Samples Nos. 3, 4 and 5 were distilled after partial drying of the grass, whereas it is usual to distil lemongrass immediately after cutting. This may have some effect on the citral content of the oil, though the Imperial Institute has no information on this point.

Conclusions

It would seem, from the results of examination of the five samples received, that the grass must be fully mature before cutting, which probably means reducing the number of cuttings per year, and that the grass should be cut after a spell of dry weather. Other aspects which might well be considered are frequent transplanting of the grass tufts into suitably manured ground, and distillation of the freshly-cut grass without partial drying.

SOYA BEANS FROM NIGERIA

By N. S. Corney, B.Sc., A.R.I.C., and H. T. Islip, B.Sc., F.R.I.C.

The Agricultural Department, Nigeria, has recently been carrying out experimental work on soya beans with the object of testing the possibility of growing these beans for export and for local consumption. So far types which are known locally as Benares and Malayan have been most successful, but many more are still in the earlier stages of trial.

In connection with these experimental trials samples of 35 strains were sent to the Imperial Institute for examination with a view to ascertaining the most suitable for local consumption or for export. The results of this investigation are given below:

Description

76 X *Malayan*. Yellowish buff-coloured beans, occasional beans green or brown. Even in size; slight signs of insect attack. Sample generally of good appearance.

77 X *Trinidad.* Yellowish buff-coloured beans, occasional beans green or brown. A few showed signs of insect attack. Beans plump; sample generally of good clean appearance.

78 X *Benares.* Mainly yellowish buff-coloured beans with some green beans present. Small in size; some signs of insect attack; pieces of material resembling brick débris present.

79 X 35*S*/277. Brownish buff-coloured beans with some green beans present. Fairly plump, but rather uneven in size. Some husk and other foreign material present.

80 X 35*S*/332. Yellowish buff-coloured beans with a few green and purple-tinged beans present. Fairly plump and even in size, except for occasional shrivelled beans. Some husk present.

81 X 37/*S*38. Buff-coloured beans with a number of green and a few brown beans present. Mixed in size but mainly medium. Husk and foreign material present.

82 X 36/*S*58. Buff-coloured beans; a number of brown beans also present. Mixed in size but mainly medium with a number of shrivelled beans. Some husk.

83 X 34*S*/51. Buff-coloured beans with a number of green, brown and purple-coloured beans. Very mixed in size, fairly large predominating. Some husk. Slight sign of insect attack.

84 X *Yellow Large.* Pale buff in colour with many pale green and some brown beans. Generally flat beans, fairly large but not really plump; many somewhat shrivelled. Some husk present. Not a very good sample in appearance.

85 X *Poona Black.* Shiny black in colour with a very few chocolate-coloured beans. Very small flat beans. Sample contained a few tufts of hairy material and a small amount of husk.

86 X *No.* 459. Buff in colour with a number of dark, purple and green beans. Medium and fairly even in size.

87 X *No.* 27. Black-coloured beans, small to medium in size. A few broken beans were present.

88 X *No.* 16. Black-coloured beans, occasional beans being without the outer black skins. Small to medium in size, some beans a little shrivelled.

89 X *No.* 29. Mixture of pale green and buff-coloured beans with green predominating, a few purple and light brown beans present. Small in size. Slight signs of insect attack.

90 X *Lanoe.* Yellowish buff-coloured beans. Fairly large in size. Appearance of sample good.

91 X *Sirsa.* Buff-coloured beans with many green and light brown beans present. Small in size, rather flat in shape, with a few beans shrivelled. Some beans had lost their outer coats and there were signs of insect attack. Not a good sample in appearance.

92 X *No.* 28 *E.B.* Buff-coloured beans with a number of shrivelled brown and green beans present. Medium in size. Signs of insect attack.

93 X *Misc.* 33 *Dixie.* Buff-coloured beans with a number of

somewhat shrivelled brown, green and purple beans present. Medium in size with a number of broken beans. Signs of insect attack.

94 X *Head Green*. Pale green in colour with a few buff, brown and purple beans. Small in size with some shrivelled.

96 X *Fartlamy*. Black-coloured beans with a few pink beans devoid of their outer skins. Medium in size. Generally a fairly good-looking sample.

97 X *Mokolo*. Dark buff-coloured beans. Medium and fairly even in size. Clean sample.

98 X *Palmetto*. Dark buff in colour with occasional pale green, brown and purple beans present. Medium in size.

99 X *Lassa No*. 4. Dark buff in colour with many green and brown beans present. Small to medium in size, some beans shrivelled. Some husk present in sample. Slight signs of insect attack.

100 X *Dixie*. Buff-coloured with a few green, brown, purple and patchy beans present. Medium in size. Signs of insect attack and tufts of hair in sample.

101 X *Jubiltan No*. 65. Black in colour with a few grey beans present. Fairly large beans with some broken and some others shrivelled. Slight signs of insect attack and some husk present.

102 X *Hernon No*. 18. Buff in colour with a few brown, green and pink beans. Small to fairly large in size with a few shrivelled beans and some husk present.

103 X *Hernon No*. 55. Dark buff in colour with a few brown, green and purple-tinged beans present. Fairly large and even in size except for a few shrivelled beans.

104 X *Hernon No*. 107. Buff-coloured with a few brown and purple-tinged beans. Fairly large in size, with a number of shrivelled beans present. Some husk in sample.

105 X *Potchefstroom No*. 184. Dark buff-coloured beans with some discoloured beans present. Fairly large in size but some shrivelled.

106 X *Potchefstroom No*. 51. Buff-coloured beans, some with brown, green or purple tinges. Medium sized, a few shrivelled. Slight sign of insect attack.

107 X *Illini No*. 7. Dark buff in colour, a very few with a green tinge. Fairly large in size with a very few small shrivelled beans present. Some husk in sample.

108 X *Early Spring*. Buff and green-coloured beans in approximately equal numbers; a few brown beans present. Medium sized.

168 X *Pero Yellow*. Yellowish-buff in colour with a very few green beans. Small in size, with a fair proportion of shrivelled beans. The sample contained a few dark brown seeds which were obviously not soya beans.

178 X *Black Forage*. Black-coloured beans, but a few which

had lost their seed-coats were buff. Medium sized. Sample contained some husk and stalks.

179 X *Dixie ex Riyem.* Buff-coloured beans with a few green and brown shrivelled beans present. Medium in size. Signs of insect attack.

The beans of the present samples are generally rather smaller and less plump than those of the previous samples of soya beans from Nigeria examined at the Imperial Institute. The best of the present samples compare reasonably well with the previous samples, but on the whole they are somewhat inferior in appearance.

Results of Examination

The results of examination of the present samples of soya beans are shown in the table on page 11 in comparison with the ranges of figures obtained with ten samples of the beans from Nigeria previously examined at the Imperial Institute and with recorded analyses of beans from other sources.

The content of phosphatides (glycerophosphoric acid esters) of a number of the samples was determined to ascertain whether this is similar to that of soya beans grown elsewhere as the soya bean is an important source of the phosphatide lecithin. Owing to the complex composition of soya beans the quantitative estimation of the amount of phosphatides in the bean is, however, one of considerable difficulty, with the result that the apparent phosphatide content varies with the method employed. The method adopted in the present instance was a modification of that of Rewald (*J. Soc. Chem. Ind.*, 1937, **56**, 77T). The beans were extracted by procedure (4), first with a mixture of alcohol and benzene, and then by alcohol alone. Impurities were removed as described by Rewald, but the final estimation of phosphorus was made after wet oxidation (by nitric and sulphuric acids) and not ignition as given in the method. The amount of phosphatides (as lecithin) was calculated from the expression, lecithin$=$weight $P_2O_5 \times 11{\cdot}366$. The whole process is a very tedious one and for this reason only a small number of the present samples was examined in this way.

Remarks

Comparing the results of examination of the present samples of soya beans from Nigeria with the ranges of figures for those previously examined, it will be seen that in size the present samples are generally somewhat smaller; none of the samples approaches a weight per 100 seeds of 25 gms., whereas 13 of them are lighter than the minimum of 10·7 previously obtained, the beans of samples 85 X and 91 X being less than half this figure.

With regard to composition, three of the present samples (85 X, 89 X and 99 X) have a lower oil content than the minimum of the previous samples; thirteen samples are, however, richer in oil, samples 83 X and 160X containing approximately 3 and 4 per

cent. respectively more oil than the previous maximum. Concerning the protein content, it will be observed that no less than 23 samples have less than the previous minimum, sample 106 X having the least protein, and that no sample reaches the previous maximum. Taking the sum of the oil and protein contents, the best samples of the present series are 168 X (with 60·2 per cent.), followed by 179 X, 92 X, 76 X and 93 X in this order; that is, of the 35 present samples five have an oil and protein content of over 59 per cent. In the case of the ten samples examined previously six of them had over 59 per cent. oil and protein, two of these six having more than the highest figure (60·2 per cent.) now obtained, with one previous sample (No. 3) containing 62·6 per cent. oil and protein. The acidity of the oil extracted from the present samples agrees with the range of the previous samples in all cases.

It is clear from the foregoing that, speaking generally, the present samples are inferior to those examined previously in size; they contain rather more oil, but considerably less protein, and the total oil and protein content is generally lower than that of the previous samples. All the figures, however, fall within the recorded ranges, so that none of the samples should be regarded as abnormal.

With regard to the phosphatide content of the present samples, as already stated, the apparent phosphatide content is subject to some variation according to the method of analysis employed. For this reason it is difficult to provide comparative figures, but the results of examination of the eight present samples, although furnishing generally somewhat lower figures, are in reasonable agreement with those recorded by Horvath, and indicate that the present beans are similar to those from other sources as a source of lecithin.

The five present samples richest in oil and protein (viz. 168 X, 179 X, 92 X, 76 X and 93 X) are all yellow or buff-coloured beans, and yellow beans are preferred by the trade. It is suggested, therefore, that these strains be utilised for export. Black beans do not find favour in the trade, although colour seems to make little difference to the oil and protein content (Sample 101 X containing 59·0 per cent. is black) though it was observed that the black beans furnished oil of a greenish colour; these might be reserved for local consumption.

Although soya beans are graded according to appearance it is interesting to note that, from the results of examination of the present samples, the largest beans do not necessarily have the best oil and protein content. Thus Sample 168 X, the best sample from the oil and protein standpoint with 60·2 per cent., weighed 9·4 gm. per 100 seeds, whereas Sample 77 X (weight per 100 seeds, 19·0 gm.) contained 58·7 per cent. oil and protein. Also, the general appearance of the sample has little bearing on the actual value of the beans from the nutritional point of view.

COMPOSITION OF SOYA BEANS, NIGERIA

Sample No.	Weight of 100 beans. gm.	Moisture, per cent.	Oil, per cent.	Crude Protein, per cent.	Total of Oil and Protein per cent.	Acid Value of Extracted Oil, mgm. KOH/gm.	Phosphatides (as lecithin), per cent.
			PRESENT SAMPLES.				
76 X	9·5	8·9	18·1	41·4	59·5	1·4	1·4
77 X	19·0	8·6	19·9	38·8	58·7	1·2	
78 X	9·0	8·6	17·7	41·3	59·0	1·4	
79 X	13·7	8·5	20·6	36·6	57·2	1·3	
80 X	14·3	9·5	21·5	33·2	54·7	1·4	
81 X	13·8	9·5	20·9	34·4	55·3	1·2	
82 X	13·9	9·5	20·7	35·4	56·1	1·3	
83 X	16·0	9·3	23·0	33·0	56·0	1·4	1·2
84 X	14·1	9·5	20·5	34·7	55·2	1·5	
85 X	5·0	9·6	14·6	41·8	56·4	1·7	1·2
86 X	11·8	10·2	18·1	40·1	58·2	2·2	
87 X	8·6	10·1	19·1	37·3	56·4	1·2	
88 X	11·4	9·7	18·3	38·8	57·1	1·2	
89 X	7·7	9·8	16·3	41·5	57·8	1·6	1·4
90 X	15·2	9·6	18·3	39·3	57·6	1·5	
91 X	5·0	9·0	18·3	38·2	56·5	2·0	
92 X	10·1	10·1	17·8	41·8	59·6	3·0	
93 X	10·4	10·1	17·7	41·6	59·3	1·5	
94 X	7·0	10·3	19·0	37·7	56·7	2·0	
96 X	10·9	10·0	18·2	39·0	57·2	1·6	0·8
97 X	11·8	9·6	20·9	31·6	52·5	1·2	
98 X	12·8	9·8	18·9	37·8	56·7	1·2	
99 X	8·3	9·9	15·9	42·6	58·5	2·6	1·3
100 X	10·1	9·6	17·8	41·0	58·8	1·7	
101 X	15·0	9·7	18·6	40·4	59·0	1·7	
102 X	15·6	9·6	20·2	36·9	57·1	1·3	
103 X	16·4	9·5	20·6	37·1	57·7	1·4	1·3
104 X	17·7	9·6	19·8	37·7	57·5	1·1	
105 X	15·7	9·8	20·9	32·0	52·9	2·5	
106 X	13·9	9·5	24·3	30·9	55·2	2·3	
107 X	18·4	9·9	21·0	33·0	54·0	1·9	
108 X	16·0	9·6	20·6	34·5	55·1	1·8	
168 X	9·4	9·5	17·2	43·0	60·2	2·4	1·7
178 X	11·5	9·7	19·4	35·9	55·3	1·7	
179 X	10·3	9·4	18·9	40·9	59·8	2·0	
Range of Previous Samples	10·7 to 25·2	9·3 to 10·3	17·3 to 19·8	39·6 to 43·3	58·4 to 62·6	1·2 to 3·2	—
			RECORDED ANALYSES				
*Hundreds of Samples examined by the U.S. Bureau of Chemistry**							
	Max.	9·42	24·20	50·30	—	—	—
	Min.	5·02	13·50	29·60	—	—	—
	Aver.	8·0	18·0	40·0	—	—	—
Average Composition of Manchurian Export Beans							
		8·5†	18†	40†	1·35‡ to 3·85	1·6§ to 3·0	

* Bailey, Capen and Leclerc. *Cereal Chemistry*, 1935, **12**, 444.
† Horvath. *The Soybean Industry*, p. 4.
‡ Markley and Goss. *Soybean Chemistry and Technology*, p. 65.
§ Horvath. *The Soybean Industry*, p. 112.

Summary

The present samples of soya beans, although somewhat inferior to the previous samples in appearance and composition, are, with occasional exceptions, of good quality. The present demand for soya beans in the United Kingdom is much greater than the supply. Considering this fact, the better quality yellow or buff-coloured beans would find a ready market in this country at a price, now, of about £40 per ton, f.o.b. (March, 1947). The poorer quality, black, green or mixed coloured beans should be reserved for home consumption in Nigeria. From the results obtained, and having regard to the difficulties attending the determination of phosphatides in the beans, it would appear that the present samples would provide a fair source of lecithin.

WATTLE BARK FROM JAMAICA

By F. Major, B.Sc., A.R.I.C., and R. W. Pearman, B.Sc., A.R.C.S., A.R.I.C.

The Blue Mountain area of Jamaica has been famous for the production of coffee for very many years but damage by soil erosion has gradually become more and more severe until at the present time the output of coffee from this area is very small indeed. As it is considered by some authorities that it might not be possible to re-instate coffee cultivation on many of the steeper slopes, alternative crops have been suggested. Among those which have been considered as possible alternatives is the wattle tree. Already there exist in Jamaica some experimental plantings of these trees at Cinchona (the old agricultural station in the Blue Mountains) which have grown very well up to now and are said to be comparable with the rate of growth in East Africa. Large areas are available where wattle could be planted, both in the Blue Mountains and on some of the steeper and higher slopes in the Island.

Before active steps are taken to establish a wattle bark or extract industry in Jamaica, it is essential to prove that the locally-produced bark is of normal composition and compares favourably with this product from other countries. With this end in view two samples of wattle bark were examined at the Imperial Institute. These were received in October, 1946, from the Commissioner of Commerce and Industries, Jamaica. They consisted of (*a*) black wattle bark (*Acacia mollissima*) stripped from a 7-year-old tree, which had a girth of 2 ft. 9 ins. at branch height, and was 29½ ft. high up to the base of the crown; and (*b*) green wattle bark (*A. decurrens*) taken from a tree of the same age and with a girth of 1 ft. 9 ins. and a height of 25 ft.

These samples were examined at the Imperial Institute and the following report was made upon them.

Description of Samples

The sample labelled "Black Wattle Bark (*Acacia mollissima*)" consisted of pieces of bark up to 50 cm. in length and from 2-8 mm. in thickness. The outer surface of the bark was greyish-brown in colour, the inner surface being brown and in many cases stained.

The sample labelled "Green Wattle Bark (*A. decurrens*)" consisted of pieces of bark up to 42 cm. in length and from 2-7 mm. in thickness. The outer surface was greyish-brown in colour, but slightly darker than the other sample, the inner surface being brown and in many cases stained.

Results of Examination

Representative portions of each sample were ground in a disintegrator to pass a $\frac{1}{16}$th inch mesh sieve, and the ground material examined by the Provisional Official Method of Quantitative Tannin Analysis of the British Section of the International Society of Leather Trades' Chemists, with the following results:

		Black Wattle Bark.*	Green Wattle Bark.*
Moisture	*per cent.*	12·4	12·3
Insoluble matter	,,	43·3	49·7
Extractive matter (soluble non-tannins)	,,	5·1	4·5
Tannin	,,	39·2	33·5
Ash	,,	2·5	3·7
Tintometer Readings†			
Red units		5·8	6·7
Yellow units		14·0	16·7

* *Analysis made by the method stated above employing the Proctor extractor, and Hide Powder—Batch C11.*

† *Determined for a solution containing* 0·5 *per cent. tannin in a* 1 *cm. cell.*

The chemical examination of the present samples of wattle bark from Jamaica shows them to contain satisfactory amounts of tannin, especially the black wattle, the amount of tannin usually found in mature (7-9 years old) air-dried bark (both green and black) being approximately 35 per cent. The extractive matter (soluble non-tannins) is, however, low, being about 5 per cent., as compared with the usual figure of 10 per cent., and the tintometer readings for yellow are high.

Although the tannin content of green and black wattle barks of similar age is approximately the same (C. O. Williams, *South African Department of Agriculture, Science Bulletin*, No. 74, p. 10), according to the Director of Forestry in a pamphlet entitled *South African Wattle Bark and Wattle Extract*, April, 1941, only black wattle is now grown in South Africa for bark production. The advantage that *Acacia decurrens* (green wattle) has over *A. mollissima* (black wattle) by virtue of its greater pest-resistant qualities, is considered to be more than offset by the undue redness of extracts of the former.

In the case of the present samples there are indications (stained inner surface of bark, low soluble non-tannins, and high tintometer readings), that the barks may not have been correctly dried, or they

may have been dried in the rainy season. According to C. O. Williams (*South African Department of Agriculture, Science Bulletin*, No. 63, pp. 41-43) bark when dried in wet weather often becomes mouldy, especially on the under sides, away from strong sunlight, where the bark remains damp for a longer time. Such bark is usually bought by dealers at a discount, as tanners are reluctant to accept material of this type, chiefly owing to the danger of the moulds introducing undesirable effects in the tan pits.

Analytical figures for these incorrectly dried barks show that there is a considerable reduction in the amount of total soluble solid matter originally present in the bark, though as this is accompanied by a reduction in the amount of soluble non-tannins present, the tannin content of the badly-dried bark is scarcely affected.

As typical examples of the effect of drying, the following figures by Williams (*loc. cit.*, p. 43) expressed (apart from tintometer readings) on the perfectly dry material may be cited:

		(*a*) Portion dried under shelter	(*b*) Portion subjected to mould growth
Insoluble matter	*per cent.*	43·5	48·5
Soluble non-tannins	,,	10·2	5·4
Tannins	,,	46·3	46·1
Tintometer Readings:			
Red units		5·0	6·7
Yellow units		4·7	12·7

It will be noted that, in addition to the lowering of the soluble non-tannin content, there is a marked deepening of colour with faulty drying, which depreciates the commercial value of the bark as a tanning material. Making due allowance for the moisture contents of the present samples of bark, it will be seen that the figures for the Jamaica barks are comparable with those given under (*b*) above, i.e. they show low soluble non-tannins and relatively high tintometer readings. This, taken in conjunction with the appearance of the inner surface of some of the present barks, would indicate that they have been incorrectly dried, or dried during wet weather, and subjected to a certain amount of mould growth.

Regarding the possibility of preparing suitable extracts from the present barks, assuming a moisture content of 20 per cent. in the final product, an extract prepared from both of the barks would contain approximately 70 per cent. tannin. According to the Director of Forestry, South Africa (*loc. cit.*), South African extract contains a guaranteed 60 per cent. tannin and frequently up to 63 per cent., while commercial samples are on the market containing up to 70 per cent. tannin.

Conclusions

With more careful drying, wattle barks similar to the present samples would probably furnish lighter-coloured extracts which

would still contain very satisfactory amounts of tannin, particularly in the case of the black wattle, and such barks (and extracts prepared from them) would find a ready market in the United Kingdom.

With regard to the extract, however, it should be noted that if, as seems likely with better drying, more total soluble matter is retained in the bark, the amount of soluble non-tannins will increase. This will result in the ratio tannin : non-tannin being reduced, so that the resulting extract would contain less than the 70 per cent. tannin possible with the present samples. There is no reason to suppose, however, that the extract would contain less than 60 per cent. tannin, the amount guaranteed in Natal wattle extract.

ORANGE OILS FROM PALESTINE

By H. T. Islip, B.Sc., F.R.I.C., and F. Major, B.Sc., A.R.I.C.

In an earlier issue of this Bulletin (1946, 44, 5) were published the results of the examination of six samples of genuine lemon oil prepared in Palestine. The purpose of this investigation was to obtain analytical data as no figures for authentic samples of this oil appeared to have been published hitherto.

More recently four samples of orange oil prepared in Palestine were received from the Liaison Officer to the Palestine Government through the Ministry of Food. These samples had been requested so that analytical figures could also be obtained for authentic samples of genuine orange oil. Such data, it was considered, would be of interest to supplement those already published by the Imperial Institute for Palestine lemon oils.

The four samples of orange oil examined were :

1. *Machine-expressed.* A golden-brown mobile oil with the characteristic odour and taste of sweet orange oil.
2. *Hand-expressed.* A pale yellow oil with a slight greenish tinge. Its odour was milder and less pleasant than that of Sample 1 and its taste was rather weak.
3. *Machine-expressed.* An amber-coloured oil with the characteristic odour and taste of sweet orange oil.
4. *Machine-expressed.* A dark amber-coloured mobile oil, containing a small amount of sediment, and having the odour and taste of sweet orange oil.

Results of Examination

The oils were filtered through paper before examination. The results of examination of the clear, filtered oils are shown in the table on page 16 in comparison with those obtained for samples of orange oil from Palestine previously examined at the Imperial Institute, with the ranges of figures for sweet orange oil recorded by Parry (*Cyclopaedia of Perfumery*) and with the requirements of the British Pharmaceutical Codex, 1934, for this oil.

CONSTANTS OF ORANGE OIL FROM PALESTINE

	Present Samples.				Previous Samples.		Ranges of constants for sweet orange oil (Parry).	Oil of sweet orange (British Pharmaceutical Codex, 1934).
	Sample 1 Machine-expressed.	*Sample* 2 Hand-expressed.	*Sample* 3 Machine-expressed.	*Sample* 4 Machine-expressed.	1931.	1932.		
Specific Gravity at 15·5°/15·5° C.	0·8500	0·8565	0·8524	0·8490	0·860	0·8495	0·848 to 0·854	0·848 to 0·852
Optical Rotation α_D 20° C.	+97·8°	+96·8°	+96·5°	+99·0°	Too dark to determine	+98·58° at 18° C.	+94° to +99°	+95° to +99°
Refractive Index n_D 20° C.	1·4742	1·4750	1·4749	1·4746	1·4750	1·4730	1·4725 to 1·4750	1·472 to 1·474
Aldehydes, as decylic*, *per cent.* (*w/w*)	1·28	0·94	1·33	1·15	—	—	1·5 to 3·0	—
Non-volatile matter, *per cent.* (*w/w*)	3·16	3·84	5·43	2·28	13·9	2·7	1·5 to 4·0	2 to 4

* *Analyst* 1934, **59**, 105-108.

Remarks

It will be observed from the table of results that the constants of Sample 1 fall within the recorded ranges for sweet orange oil, and comply with the requirements of the B.P. Codex for this oil, in all respects except the aldehyde content, which is a little low. Sample 3, another machine-expressed oil, also has a low aldehyde content and, in addition, the non-volatile matter is in excess of the maximum for a normal sweet orange oil, the remaining constants being in line with the recorded ranges and also with the B.P. Codex requirements except for a very slightly higher refractive index. The constants of Sample 4, the third machine-expressed oil, apart from the aldehyde content which is rather low, fall within the recorded ranges for sweet orange oil; the oil complies with the requirements of the British Pharmaceutical Codex in all respects except that the refractive index is insignificantly higher than the maximum stated. The differences in the constants of these three samples in comparison with those of normal sweet orange oil are, however, small and they are unlikely of themselves to have a material influence on their market value.

In the case of the hand-expressed oil, Sample 2, it will be noted that the specific gravity is high and the aldehyde content very low; the remaining constants fall within the recorded ranges for sweet orange oil, though the refractive index is very slightly above the maximum given in the B.P. Codex. In this instance the differences in the constants in comparison with those of normal sweet orange oil are of some significance, tending to reduce the market value of the oil.

Although it would be unwise to draw definite conclusions from the analysis of such a small number of samples, the significant feature of the four oils recently examined is a tendency for the aldehyde content to be low. This may, or may not, be characteristic of Palestinian sweet orange oil. This point can only be established after a much greater number of samples have been examined.

NOTES

The Cultivation of Jasmine and Preparation of the Perfume.—*Botanical Source.*—The jasmine which is cultivated at Grasse for extraction of its perfume is *Jasminum grandiflorum* L., N.O. *Oleaceae* (Spanish or Catalonian jasmine). *J. grandiflorum*, is not cultivated at Grasse on its own root but is grafted upon the ordinary white jasmine (*J. officinale*), which grows wild over extensive areas of Southern Europe, including Catalonia, the Alpes-Maritimes and Italian Liguria, and is also known in the northern parts of Europe, including Great Britain.

Areas and Volume of Production.—Jasmine is produced largely

in the South of France; much smaller quantities are obtained in Egypt, French Algeria, India (South Canara), Italy (Liguria) and Syria.

In a normal year the total weight of blossoms collected in France is said to be about 750 metric tons, distributed in the following communes around Grasse:

Grasse—Montauraux	approx.	450 *m. tons.*
Mouans—Mongins	,,	200 ,,
Pegomas—Cannes	,,	100 ,,

Soil and Climatic Requirements.—The selection of ground for the cultivation of jasmine is most important in view of the exacting requirements of the plant. Among the factors which should be considered when selecting land for the plantation of jasmine are: (1) irrigation should be easy to provide; (2) the land should have a southern aspect in order to avoid the winter frosts; and (3) the soil itself should be easily drained, light and friable and free from stones. According to a French periodical (*Revue des Marques*, August, 1924) the ideal soil is that which has been sown with cereals for many years or has been used for growing forage crops. If ground is used which has been planted with trees (more particularly fig, mulberry, olive, or peach) there is a danger that a disease may develop which is called in Provence "la mouffe," and is discussed below. It causes the rapid extermination of jasmine.

Cultivation.—In the autumn the ground, previously dressed with manure if necessary, is deeply dug to a depth of at least three spits: all plant remnants met with are removed. This work is often done by hand in France, as on terraced land it is difficult to use machinery. In the early spring—February or March—cuttings of *J. officinale* of length about 16 in. are planted. These are known in France as "Cavillons." Details of the recommended planting system are: (1) spacing of the rows is 40 in.; (2) spacing between plants is 4 in.; (3) cuttings are planted so that three-quarters of their length is below ground. (The necessary number of cuttings per acre according to this method is 39,200); and (4) during the summer following planting the cuttings should be watered to help them to take root.

On these preliminary operations the following comments may be made: (1) on an average, a Grasse workman will dig about 24 sq. yds. per day to a depth of three spits; (2) the planting of the cuttings is said to require about ten man-days per acre; (3) in April of the year following planting or, at the latest, the year after that, grafting is commenced, using cuttings of *J. grandiflorum* (of length 16 in.) which have been kept during the winter in river sand to protect them against the frost. The stocks of *J. officinale* are freed from their branches by clipping: cuts $\frac{3}{4}$ in. long are then made in the main stem by a woman, following whom is the grafter who introduces the scions. In a vigorous stock two scions may be

introduced, each bevelled to ¾ in. A third (female) worker ties the cuttings in place with raffia, and a labourer then covers up the stock with earth. It is reckoned that this team of four persons can graft about 2,000 plants a day. When the first shoots of *J. grandiflorum* appear, indicating that the grafting has taken, the earth is laid back. It is considered that a man can unearth about 600 to 700 sq. yd. of land in a day. About 50 to 60 per cent. of the scions take and it may be assumed that 16,000 to 20,000 plants per acre remain for production. During the first summer these may have to be watered three or four times a week. A small harvest may be obtained at the end of the season. During this and the following season the following cultural measures are necessary:

(1) *Tamping*.—In France this is usually done by hand, using little trowels, and it is reckoned that a good worker can cover about 360 sq. yd. in a day. Where it is possible, there is obviously scope for the introduction of suitable machinery for this work.

(2) *Pruning*.—The plants are pruned early in the following spring by women, who each cover, on an average, 400 to 450 sq. yd. of the plantation per day.

(3) *Tying up*.—When the branches are fully developed, they are tied to wire suspended at a height of about 15 in. by iron or wooden posts about 4 yd. apart. It is found that, working as above, a woman can tie an acre of jasmine in about five days.

(4) *Irrigation*.—In Grasse this is commenced towards the 15th June and is continued until October. The method of construction of the irrigation channels is: crosswise to the jasmine rows, at distances of about 30 yd., channels are constructed of re-inforced cement or D-shaped glazed-brick drain pipes of 6 in. diameter. These channels are built with a drop of about 1 in 30, which allows a maximum gravitational flow of about 4,400 gallons of water per hour. About 22,000 gallons of water per acre per week are needed for irrigation in a normal year.

(5) *Manuring*.—In the Grasse region no stable manure is used, but small quantities of sulphate of ammonia are added when the plants are watered.

(6) *Hoeing*.—The ground is hoed in June and July, and is weeded twice before harvesting.

(7) *Harvesting*.—Harvesting is started in fine weather about the middle of July, and is continued according to demand until the beginning of the cold weather in October. The flowers, collected each day soon after they open, are protected as far as possible from heat and rain, and as short a time as is convenient is allowed to elapse before enfleurage or solvent treatment, in order to avoid fermentation. In the years immediately preceding the Second World War, it was reckoned that about 3,000 women were occupied at Grasse each season in picking jasmine. They were paid on a piece-work basis at the rate of 3 to 5 francs per kilogram, a picker being able to gather about 4 or 5 kg. in six hours. It is

reckoned that there is an average of 8,000 to 10,000 flowers per kilogram.

Yield of Flowers, Concrete and Absolute.—The plants give a small yield of flowers in the first year. In the second year they yield from 200 to 300 kg. per hectare, and this is said to rise to 4,000 kg. in the fifth year. This yield is maintained until about the eleventh year, after which it decreases. Further commercial yields of flowers may be obtained, however, up to the fourteenth or fifteenth year. The yield of "concrete" from the dried flowers by the volatile solvent method is about 0·25 per cent. and from this can be obtained 40 to 45 per cent. of absolute, i.e. an overall yield of about 0·10 to 0·12 per cent. Approximately three times this yield may be obtained by using the enfleurage method.

Post-Harvest Operations.—When the harvest is complete the bushes are banked up with earth to a height of 1 ft. to protect them from frost. In spring they are exposed again and pruned to ensure straight and regular growth.

Diseases and Pests.—The principal enemies of jasmine are (i) Root-rot, termed in France "la mouffe," and (ii) the caterpillar of a moth (*Glyphodes unionalis*), which eats the buds of the plant.

1. Root-rot is caused by two fungi, *Rosellina aquilla* and *R. necatrix*; the bushes are rapidly killed by it. The only remedy is said to be an early heavy treatment with ferric sulphate (sulphate of iron), but this is rarely completely effective. It is best to minimise the risk of root-rot by planting the crop in a well-drained soil, which has been thoroughly cleansed of decaying vegetable matter, and disinfected by the use of carbon disulphide or a 2 per cent. solution of commercial formalin.

2. *Glyphodes unionalis.* No cheap practicable method of eradication of this pest has yet been found. Arsenical sprays prevent its multiplication, but their use in France for this purpose is forbidden by law. The use of nicotine mixture, consisting of 97 parts of non-calcareous water, 1½ parts of 10 per cent. nicotine, 1½ parts of de-natured alcohol, and ⅕ part of black soap, sprayed on the buds, is said to be effective in the control of the caterpillar. Sodium fluoaluminate (cryolite) solution of 1 per cent. concentration has also been used.

Preparation of the Perfume for Market.—The two different methods which are used at Grasse are briefly described below.

(1) *Enfleurage.*—Certain flowers, one of which is jasmine, continue to synthesise aromatic products after being removed from the parent stem, and for such flowers the use of "enfleurage" to extract the perfumery material is feasible. Briefly, the flowers are put on glass trays framed in wood, smeared with purified fat (lard or beef suet or a mixture of the two are most commonly employed), and are removed mechanically or by manual labour after one to two days, a fresh lot of flowers being added. The process is repeated until the fat is suitably saturated with essential

oil. The oil-containing fat finally obtained is treated with an equal weight of 96 per cent. alcohol to dissolve the essential oil. On concentration of the alcoholic solution, followed by cooling, to separate some of the fat, a flower " concrete " remains. When the " absolute " from the flowers is required, this concrete is dissolved in alcohol and the solution is cooled to — 15° C., when most of the wax separates out, leaving a maximum of 50 per cent. of absolute. Such a jasmine absolute is naturally expensive and finds a use in the finest perfumes only. In connection with this process it should perhaps be noted that, in order to avoid waste, the treated flowers may afterwards be extracted with a volatile solvent so as to obtain the residual " oil from frames," a second-grade product.

(2) *Solvent extraction,* using petroleum ether or cystallizable benzene. The process is carried out in one of several different kinds of apparatus, each designed with the object of efficiently extracting the fats, waxes and essential oils from the flower-heads.

One kind of apparatus used is briefly described in an article in *La Parfumerie Moderne* (October, 1929, Vol. 22, No. 10, pp. 699-703). It is of cylindrical shape, and is fitted with perforated shelves on which are thin layers of the flower-heads. After loading the shelves with flower-heads, the apparatus is closed, and the flower-heads are thrice extracted with solvent, which is subsequently led off to the concentrator, solvent remaining in the flowers being recovered by steam distillation and separation in the customary manner. In the concentrator the solvent is removed in vacuo and the commercial jasmine "concrete" remains behind. This "concrete" consists not only of essential oil, resins and fatty glycerides, but also of insoluble waxy matter. From it jasmine "absolute" can be prepared by extraction with a sufficient quantity of absolute alcohol to dissolve the essential oil. The solution so obtained is cooled to a low temperature by means of a cooling agent, when most of the waxes separate out. The resulting liquid is then submitted to a treatment similar to that described above in paragraph (1) for jasmine "absolute."

The several processes are carried out so that the lowest possible temperatures are maintained and the fragrance of the residuum is unimpaired. The comparative value of the two processes described above has led to much discussion, but it now seems clear that the relative yield of volatile oil obtained by steam distillation of the absolutes is 2½-3 to 1 in favour of enfleurage. One investigator, Von Soden (*Deutsche Perf. Ztg.*, 1925, Vol. II, p. 149), expresses the opinion that, despite its inferior yield, the solvent process is preferable because it recovers precisely those odorous compounds, which, owing to their inferior volatility, remain behind in flowers subjected to the enfleurage process. Guenther states that the yield of absolutes by the volatile solvent method is 0·14 per cent. while 0·44 per cent. of absolute can be obtained by the enfleurage

process. It is doubtful if such a high yield could be obtained commercially.

Costs of Production

The following details of estimated establishment costs and annual costs of the jasmine plantation have been obtained from the account of French jasmine production given by M. Boischot in his article in *Le Progrès Agricole et Viticole* mentioned in the bibliography given below. The costs listed have been converted approximately into pounds sterling at the average 1937 rate of 123·44 francs to the pound.

ITEMS OF EXPENDITURE IN JASMINE CULTIVATION

Costs of Establishing the Plantation per Hectare ($2\frac{1}{2}$ *acres*)

	Francs.	£
Digging to a depth of 0·80 m. ($31\frac{1}{2}$ ins.)	30,000	243
Purchase of 100,000 shoots	1,500	12
Planting of shoots	1,500	12
Grafting	7,000	57
Raffia for Grafting	1,600	13
Posts and Wire	4,000	32
Irrigation Channels	6,000	49
Reservoir	8,400	68
Total of Costs considered	60,000	486

Annual Costs per Hectare

	Francs.	£
Repayment on outlay at 10 per cent.	6,000	49
Rent of ground	2,000	16
Tamping—		
40 man-days at 32 francs per man-day	1,280	10
20 man-days at 32 francs per man-day	640	5
2 Weedings—		
30 man-days at 32 francs per man-day	960	8
1 Hoeing—		
30 man-days at 32 francs per man-day	960	8
Pruning—		
30 woman-days at 17·20 francs per woman-day	516	4
Light Weeding—		
15 woman-days at 17·20 francs per woman-day	258	2
Irrigation—		
10 man-days at 32 francs per man-day	320	3
Irrigation water	400	3
Fertilizer	1,500	12
Tying Up—		
15 woman-days at 17·20 francs per woman-day	258	2
Raffia and tools	500	4
Total of Costs considered	15,592	126

On the basis of a mean annual yield of 2,000 kg. of flowers, the cost of production per kilogram was in 1937 7 fr. 80 c. It can therefore be taken that, assuming the cost of harvesting the flowers was 5 fr. 50 c. per kilogram, the basic cost of production was 13 fr. 30 c. per kilogram (or $10\frac{1}{2}$d. per lb.).

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R. A. G. S.

The Determination of Pyrethrins.—Reference was made in this BULLETIN (1945, **43**, 209) to collaborative work being undertaken by Rothamsted Experimental Station, Messrs. Stafford Allen and Sons, Ltd., and the Imperial Institute. The results of this joint study have been incorporated in three scientific papers. Two of these entitled, "The Determination of the Pyrethrins in Pyrethrum Concentrates in Mineral Oil" by J. T. Martin and S. T. P. Brightwell; and "The Determination of the Pyrethrin Content of Dilute Preparations of Pyrethrum Flowers in Oil" by G. T. Bray and K. A. Lord have been published in the *Journal of the Society of Chemical Industry* (1946, **65**, Dec., 379, 382). The third paper on "The Determination of the Factor for Pyrethrin I in the Mercury Method" by G. T. Bray, S. H. Harper, K. A. Lord, F. Major and F. H. Tresadern is now in the press and will appear shortly in the same journal.

Since the above studies have been completed the Imperial Institute Consultative Committee on Insecticide Materials of Vegetable Origin has appointed a Standing Sub-Committee on Methods of Analysis of Vegetable Insecticides. One of the tasks to be performed by this Sub-Committee is to endeavour to decide which of the methods in use at present for determining the pyrethrins content of pyrethrum flowers is the most reliable and gives the most concordant results when carried out by analysts in different laboratories and under different climatic conditions. To attain this end invitations to co-operate in the study of existing methods have been sent to a large number of official departments and commercial firms throughout the world interested in pyrethrum. So far over 40 different laboratories have agreed to participate and the Sub-Committee is now engaged upon drawing up a suitable scheme for this investigation and in preparing the requisite samples for test. Countries so far represented in this collaborative study include, besides the United Kingdom, East Africa, South Africa, Australia, Belgian Congo, Canada, India, Malaya, New Zealand and the United States of America.

Tobacco Seed Oil.—Of recent years owing to the shortage of supplies of the usual oils and fats offered on the market, the use of tobacco seed oil has assumed some importance. In countries producing tobacco there is often a surplus of seed. In normal times this seed is not utilised to any appreciable extent, its use being confined to the country of production.

Tobacco seed contains from 33 to 43 per cent. of oil, the content varying with the variety and the district in which the plant is grown. The oil when cold-drawn is light yellow in colour and possesses a pleasant odour and an agreeable taste. When it is prepared by hot pressing or by solvent extraction it may have an objectionable taste, which, however, is removed by refining. The cold-drawn oil and the refined oil are free from alkaloids (e.g. nicotine) and are used for edible purposes. When hydrogenated they are suitable for the same purposes. Recent tests have shown that the edible grades of tobacco seed oil are non-toxic and have a digestibility and nutritional values equal to those of the usual edible oils. Another use for tobacco seed oil is in the manufacture of soap. For this purpose also it may be hardened by hydrogenation.

Tobacco seed oil has been tried as a paint oil. Judging from its iodine value it could not be expected to possess such good drying properties as linseed oil. There seems some difference of opinion regarding the respective merits of these two oils. Some authorities have stated that the drying properties of tobacco seed oil are equal to those of linseed oil, whereas others have reported that the former oil dries more slowly and takes longer to body than linseed oil. Nevertheless, it seems to be generally agreed that tobacco seed oil is suitable for use in the manufacture of paints and varnishes; in the preparation of stand oils and of oil-modified glycerol-phthalate-alkyd resins. A stand oil of viscosity of 30 poises and an acid value of 3·7 made with tobacco seed oil took somewhat longer to dry completely than a corresponding stand oil prepared from linseed oil. Congo copal and ester gum lacquers boiled with tobacco seed oil and driers showed favourable behaviour. Alkyd resins modified by tobacco seed oil had similar properties to linseed oil alkyd resins of similar composition. The resulting film obtained when the former oil was used possessed a somewhat higher resistance to water and had a slightly greater hardness than that when linseed oil was employed. When boiled with lead and cobalt driers tobacco seed oil gave soft elastic films.

Tobacco seed oil on analysis usually gives results falling within the following ranges:

Specific Gravity at 15/15° C.		0·9232–0·9250
Refractive Index at 20° C.		1·4755–1·4763
Saponification Value		187–191
Iodine Value,	*per cent.*	135–147
Unsaponifiable matter	,,	1·0–1·6
Thiocyanogen Value		78–82
Solidifying Point of Fatty Acids ° C.		18·0–18·2

The composition of the glycerides of tobacco seed oil has been investigated by a number of observers with varying results. The general consensus appears to be that about 10 per cent. are saturated. The unsaturated acids present are oleic and linoleic. No linolenic acid has been detected. The figures reported for oleic acid vary from 12 to 31 per cent., and for linoleic acid from 60 to 77 per cent.

The cake left after the removal of the oil from tobacco seed is rich in protein (30 to 35 per cent.) and is free from any harmful constituent. Animals eat it readily. Feeding trials carried out with the cake at the Agricultural Research Station, Guntur, Madras Province, showed that after being fed with this material for five weeks the animals showed no ill effects.

G. T. B.

Investigation Work of the Agricultural Department, Antigua.— Reference was made in this BULLETIN (1946, 44, 205) to certain experimental work that had been started by the Agricultural Department, Antigua, during the latter half of the year 1945. These trials were continued in 1946 and the results obtained have been communicated to the Imperial Institute by the Agricultural Superintendent.

In varietal experiments lasting 352 days Elephant grass gave from four reapings 40·6 tons per acre and Guinea grass 23·6 tons from the same number of reapings. With Guatemala grass and Uba cane three reapings yielded 22·3 and 14·8 tons respectively. Difficulty was, however, experienced in establishing Guatemala grass and the yields from the first cuttings were therefore from fewer plants than in the case of the other three grasses.

Similar varietal trials were made using ammonium nitrate as a fertiliser. This was applied at the rate of 2 cwt. per acre soon after establishment of the plants and again after each cutting. The results obtained showed that the use of this fertiliser gave a bigger yield per acre in each case. With Guatemala grass and Uba cane the increase was about 6 per cent.; with Elephant grass 12 per cent. and with Guinea grass 23 per cent.

In manurial experiments with Elephant grass and Guinea grass fertilisers were applied to the plants soon after establishment and to ratoons after each cutting at the following rates for each application:

Plot 1.—No fertiliser applied.
Plot 2.—2 cwt. sulphate of ammonia per acre.
Plot 3.—1 cwt. superphosphate per acre.
Plot 4.—2 cwt. sulphate of ammonia and 1 cwt. superphosphate per acre.

The plants were reaped four times. The trials showed that whilst they had not yet been conducted for a sufficiently long period to allow the results to be interpreted accurately, at this stage the

plants showed a lack of response to phosphates when applied alone.

Spacing experiments were carried out with Elephant grass. Four different spacings were tried, namely 2 × 4; 2 × 3; 2 × 2 ft. and 2 ft. rows continuous spacing. The crops were reaped three times during the 321 days' duration of the trials. The first-named spacing gave a very slightly higher yield per acre (31·5 tons) than the second and third (30·2 and 30·1 tons respectively). The continuous spacing yielded 27·6 tons per acre.

Included among the sugar-cane experiments were small-scale trials with "Methoxane" and "Standag" weedkillers applied at the rate of 9 lb. per acre. Observations indicated that a number of common weeds were killed outright by one application and that nut grass was seriously affected.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

THE COLONIAL OFFICE FROM WITHIN, 1909-1945. By Sir Cosmo Parkinson. Pp. 157, 9 × 5½. (London: Faber and Faber, Ltd., 1947.) Price 8*s*. 6*d*.

This is a delightful book by one who knows the Colonial Office from within, having entered it in 1909 and become its permanent head in 1937. The note of humour which sparkles from the first page of the Introduction is maintained most happily throughout the book. Indeed it is the right note to strike, in a survey which would tempt the author to prosiness if he had not native and secret sources of humour on which to draw unfailingly.

The build-up of the Colonial Office is clearly described—the formidable machine, the inevitable red tape, and yet the efficiency with which it achieves its purposes. An interesting point is the geographical organisation of the offices, by which Executive and Clerical Officers specialise on the different territories of the Colonial Empire. Indeed, considering the vast and varied resources of the Empire in men and materials some such specialisation is necessary. The closest possible contact is maintained between officers on duty —or on leave, for the matter of that—at home and abroad. There is an interesting comparison with the Foreign Office in this respect. If the difference of method between the two Offices is pronounced it is because either has grown up naturally on its own lines and functions in ways best suited to its separate objectives.

All through the book the personal note is most happily touched.

Praise is given to Ministers and staff alike where praise is due; and where actual praise is withheld, its place is taken by delightfully human comments.

The attitude of the Home Government to its Dependencies is particularly well described. It is important not only to pass on to the Dependencies the best advice that modern Science can give but also to train their citizens in the secrets and the application of modern scientific methods. This is the definite policy of the Colonial Secretaries whatever their political creed; it is ably supported by the whole of the scientific staff and of the expert Advisers attached to the Secretary of State. Moreover, on the administrative side the Dependencies have for many years past been trained towards the goal of self-government. Some, like Ceylon and Malta, have reached it in their internal affairs—others are very near it, and all occupy some place near or far on the same progressive road.

It was General Smuts who once said that "The British Empire is the first Empire to expand by decentralisation." That is certainly the experience and the watchword of the Colonial Empire; and its success is vindicated by recent political developments in Nigeria.

Readers of the *Bulletin* will deplore the fact that there is only one tenuous reference to the Imperial Institute, on p. 72—in spite of the fact that control of the Institute passed from the Board of Trade to the Colonial Office in 1907; the transfer became statutory in 1916 and the Colonial Secretary remained in charge of the affairs of the Institute until 1925 when control passed to the Secretary, Department of Overseas Trade. Let us hope that a new edition will give the author a chance to rectify this omission.

One or two misprints occur. On page 65, it is almost *lèse majesté* to talk of a "Secretery of State." On page 58, the post of Adviser has become an "Advisorship," presumably through the magnetism of "advisory" in the following line. But misprints are rare in a book which has been very carefully written and carefully revised, and most happily inspired throughout.

H. A. F. L.

PRINCIPLES OF AGRICULTURAL BOTANY. By Alexander Nelson, B.Sc., Ph.D., N.D.A. Pp. xvii + 556, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Thomas Nelson and Sons, Ltd., 1946.) Price 35*s*.

The *Principles of Agricultural Botany* by Dr. A. Nelson is an excellent and up-to-date textbook on the subject which should find a large demand amongst students of agriculture and others. It is a book which will appeal to even the most practical minded student of agriculture for there is little in the text which he will not find interesting or useful to him; plants taken as examples are largely those which he will either know, or will come to know, in connection with his studies in agriculture.

There are four sections to the book, the first deals with the anatomy and morphology of the flowering plant and includes some cytology and histology. The second part is a consideration of physiology: the third, of particular interest to agriculturists, is called by the author "negative factors in food production" and covers weeds; insect pests; and diseases, virus, fungoid and physiological. The fourth section, a short one, returns to the more theoretical subjects, heredity, evolution and classification.

There are parts which might advantageously have been expanded, for example, that dealing with hormones the practical importance of which is rapidly increasing; and that dealing with systematics, but the author admits that space was strictly limited and makes suggestions for advanced reading. There is much information to be found in this book, which will not have been seen before in a textbook of this nature, since results of some recent experimental work are included, such as, that done at East Malling Research Station on injection methods for diagnostic and curative purposes.

The book is abundantly illustrated with text figures, many of which are original; and with photographs, some of which are in colour. All the plates reach a very high standard of clarity and instructiveness.

I. C. S.

LAND LAW AND CUSTOM IN THE COLONIES. By C. K. Meek, M.A., D.Sc. Pp. xxvi + 337, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Geoffrey Cumberlege; Oxford University Press, 1946.) Price 21*s*.

This book is an enlargement of a series of memoranda drawn up during the war as a guide to a Colonial Office Committee on post-war problems. It deals exclusively with agricultural lands, for the prosperity of the Colonial peoples will depend, by and large, on the more appropriate use of the soil and on new local industries dependent on agriculture.

Dr. Meek traces the history of the system of land tenure of sixteen Colonies in an admirably clear and straight-forward manner. It may well be that he has erred, in his section of East Africa for example, on the side of simplification in an attempt to achieve a lucid account. Or it may be that having sifted the statements and opinions of those who have worked in the field, he finds that most of the changes introduced by Europeans, often ignorant of the old-established native systems, are not as chaotic as they may appear.

References and notes are plentiful for those who wish to study any section in greater detail. In addition to the chapters dealing with specific Colonies, there are others dealing in a more general way with Muhammadan Land Law, changes in Native African Law and such problems as registration, mortgage, freehold and leasehold.

The result is a compact book of reference for the Colonial

Administrator who should find the comparison of systems prevailing in other Colonies than his own of immense value; for the Colonial resident, be he missionary or planter, who holds land; and for the student of agriculture, history or anthropology.

Lord Hailey's scholarly introduction gives both point and direction to the whole by summarising the most pressing economic and social problems that confront the Colonial Administrations.

R. C. H. W.

AN INTRODUCTION TO CHROMATOGRAPHY. By Trevor I. Williams, B.A., B.Sc., D.Phil. Pp. vii + 100, 9 × 6. (London: Blackie & Sons, Limited, 1946.) Price 10s.

Chromatography has now reached the stage when it should be accepted as an analytical method as important as any of the older well-known methods. The two books at present available on the subject by Zeichmeister and Cholnoky and by Strain, however, are rather detailed and for the student who requires a briefer and simpler account this book has been written.

The chapters on general principles, methods and applications are admirable, while the practical hints included show that the book has been written by someone with first-hand experience. There is a very useful section on "Disc Chromatography" which provides a useful means of deciding quickly the correct adsorbent and solvent to employ in an analysis.

A further chapter is devoted to partition chromatography, while an account is also given of Tiselius's method which enables charcoal to be employed as the adsorbent. The examples of chromatography, however, could have been better chosen to be more in keeping with this type of book by selecting examples that could be tried by the student himself, i.e., separation of leaf pigments, mixtures of dyestuffs and numerous other examples employing substances easily available and familiar to the student.

The book is well illustrated, the photographs and coloured plates being excellent, while the printing and binding show a welcome return to the standard well known in pre-war days.

R. W. P.

AN INTRODUCTION TO AGRICULTURAL CHEMISTRY. By N. M. Comber, D.Sc., A.R.C.S., F.R.I.C., H. T. Jones, M.Sc., A.R.I.C., and J. S. Willcox, B.Sc., A.R.I.C. Pp. viii + 315, $7\frac{1}{2} \times 5\frac{1}{4}$. (London: Edward Arnold & Co., 1947.) Price 8*s*. 6*d*.

This work was compiled primarily as a textbook, for students studying for degrees and diplomas in Agriculture, to cover the normal syllabus in Agricultural Chemistry. The authors have confined the subject matter to the soil, fertilizers and animal nutrition and state that it is not intended to be more than an

introduction to the subject. They have purposely omitted those subjects, such as the chemistry of insecticides and fungicides, which are developing so rapidly that any information which might be given would be quickly out of date.

The first section on soil materials and soil, is an abridged and modified version of a book on the chemistry of the soil which had been published at an earlier date by one of the authors. This deals with the origin and composition of soil material; its physical and colloidal properties; the plant food contained in soil material and its availability for the growth of crops. In addition there are chapters on the formation and classification of soils. The general principles of manuring and the various types of organic manures and fertilizers are discussed in the second section of the book, which also contains a chapter on the necessity for liming the ground and the various forms in which this material may be applied. The last part of the text is devoted to animal nutrition and consists of seven chapters which deal, among other things, with the composition of the animal and its food, digestion, absorption and digestibility; metabolism; minerals and vitamins; the nutritive values of foods; the nutritive requirements of animals and the chemical constituents of cow's milk.

This book is written in a clear and concise style throughout with well defined headings and sub-headings; it also has an excellent index. It can be recommended as an introduction to Agricultural Chemistry to all who take a serious interest in the scientific aspect of Agriculture.

H. E. C.

LEATHER IN LIFE, ART AND INDUSTRY. By John W. Waterer. Pp. 320, $11\frac{1}{4} \times 8\frac{1}{2}$. (London: Faber and Faber, Ltd., 1946.) Price 50s.

This is a remarkable volume, for the scope it covers and for the interest which a study of its pages stimulates. It is divided into three parts, the first of which contains an outline of the historical development of leather, its uses since the earliest times and the organisation of the Trade Guilds and Leather Crafts. The account of the old City Companies, as they are popularly referred to to-day, will be found to provide fascinating reading to all who are interested in the social history of their country.

The second part, dealing with the Present, provides a concise survey of all the various trades comprised within the leather industry, and is at once a record for study and for reference. It is praiseworthy for the amount of information contained in a relatively small compass, since production from the raw materials of hides and skins to the finished articles of footwear, saddlery, clothing, bags, upholstery and other goods is well described and explained.

The third part of the volume is entitled "The Future," and here we find the teaching which the author has to impart. Mr.

Waterer, who is a manufacturer of leather goods, is one of the leading champions of better design in industry, and in this section after describing the facilities which exist in this country for education, with reference to the subject under review, he proceeds to present the case for research and development, for the National Register of Industrial Art Designers and for the Council of Industrial Design. Throughout the book artistic values are stressed, and conviction will be brought to the reader that leathercraft has a wealth of tradition and a future with possibilities for the highest quality in craftsmanship and design.

The book is particularly pleasing in its form and presentation. For these days the paper and excellent plates are outstanding, the plates over 100 in number, together with numerous figures, illustrating old and new productions, being a most valuable feature. The bibliography of the subject, the glossary of leathers, and various detailed information given throughout, will make the volume of great use. It should appeal to many, as it is undoubtedly of very great interest to those in the industry, and to artists, designers and the enquiring layman.

J. R. F.

PLANT LIFE OF THE PACIFIC WORLD. By Elmer D. Merrill. Pp. xv + 295, 8 × 5½. (New York: The Macmillan Company, 1945.) Price $3·50.

This work is a popular account of the plants of the Islands of the Pacific, prepared in the United States by an eminent botanist in particular to serve as a guide to American servicemen stationed in this zone. The book is one of the Pacific World Series—other volumes deal with the indigenous peoples of the Pacific, with animal, and with insect life—issued under the auspices of the American Committee for International Wild Life Protection. The Committee's object has been to supply those in the Armed Forces with a full understanding of the life and natural history of the Pacific Islands, in order to stimulate interest in their preservation.

In view of the existence of some 50,000 species in the region covered by the work, Dr. Merrill has had no light task to prepare in a book of this size a comprehensive survey. However, for this he is well-qualified having made a life study of the plants of the Pacific Islands, with many years of actual residence in the Philippines. As it is, only the more noteworthy species could receive mention, but the author seems to have chosen his material well. No previous knowledge of botany is required of the reader, and the amount of technical data included is just sufficient to enable those using the book to grasp the essential elements of botanical classification and nomenclature. The author is especially concerned that some at least of those who may be taken to one or more of these islands by force of circumstances may be encouraged to become collectors and so assist in the fuller exploration of the

local floras. It is carefully indicated in which regions new material may most probably be found. The excellence of the line drawings with which the work is illustrated deserves recognition.

E. H. G. S.

FIBROUS PROTEINS. Foreword by Sir Edward V. Appleton, K.C.B., M.A., D.Sc., F.R.S. Pp. ix + 220, $10\frac{3}{4} \times 7\frac{1}{2}$. (Bradford: The Society of Dyers and Colourists, 1946.) Price 27*s*. 6*d*.

To the chemist interested in fibrous proteins this publication (Proceedings of the first post-war Symposium held by the Society of Dyers and Colourists at Leeds) should prove of great value. Dealing with various aspects of the subjects in the light of most recent information the papers included are presented by workers connected directly with the subject concerned. Each paper is followed by a general discussion in which other workers' views are given or doubtful points are further expounded by the speaker. A wide range of references are also given after each paper.

The subjects range from the structure of proteins and fibres to the various properties and reactions of different fibres, and it will be seen that many industries besides the textile industry have an interest in fibrous proteins and that much benefit will be gained by the knowledge now available as the outcome of a scientific approach to a difficult subject.

The printing is of a good standard, while the plates and diagrams are very clear.

R. W. P.

THE PRACTICE OF SILVICULTURE. By Ralph C. Hawley. Fifth Edition. Pp. xi + 354, $9\frac{1}{4} \times 6$. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1946.) Price $4.

The first edition of this book appeared in 1921 and subsequent editions in 1928, 1934 and 1937. During these 25 years great additions to the knowledge and practice of silviculture have been made and the current edition has been thoroughly revised and enlarged and many parts rewritten.

The book has been prepared as a textbook for students and relates mainly to American conditions.

The field of silviculture, when viewed broadly, is not only to produce individual forest crops but also, while so doing, to build a permanent forest which can continue indefinitely to satisfy the objective of management. The author divides it logically into three parts defined as (1) the treatment of the stand during the period of regeneration or establishment; (2) the treatment of the stand during that portion of the rotation not included in the period of regeneration; and (3) protection of the stand against injuries of many kinds.

The book deals mainly with parts (1) and (2). Under (1), which is a consideration of reproduction methods, are carefully described in eight chapters (*a*) clear cutting with both artificial and natural regeneration, (*b*) the seed-tree method, (*c*) the shelter wood method, (*d*) the selection method, (*e*) the coppice method, and (*f*) the coppice-with-standards method. Part (2) is a consideration of intermediate cuttings and five chapters are concerned with thinnings, improvement and salvage cuttings, pruning, and methods of controlling cuttings. There is a useful chapter on slash disposal. An appendix gives the common and technical names of the tree species mentioned in the text.

The book is well produced and printed and is illustrated with clear diagrams.

R. M. J.

THE INDIAN COTTON GROWING REVIEW. Vol. 1, No. 1. Pp. 45, $9\frac{1}{2} \times 7\frac{1}{4}$. (Bombay: British India Press, January 1947.) Price Rs. 2.

This new publication is the official journal of the Indian Central Cotton Committee and will be issued quarterly. Its purpose is to make known to the public in general, cotton growers and the trade the activities of the Committee and to give statistical and other useful information relating to Indian cotton.

Included in the contents of this first number are articles by a number of authorities on cotton growing in India; the yield of rain-fed cotton and its improvement; the staple characteristics of the Punjab-American cotton crop; cotton improvement in South Gujerat; cotton prospects of Bengal; reviews of work done on cotton in the United Provinces, Mysore and Hyderabad; pre-cleaning and ginning tests on Indian cottons.

This periodical should prove of value to all those interested in the development of Indian cotton and possesses the advantage of making it possible to publish in their official journal the results of research work and other activities of the Committee, which hitherto have had to appear in various scientific journals when they did not form the subjects of official memoirs.

G. T. B.

FRUIT FALL AND ITS CONTROL BY SYNTHETIC GROWTH SUBSTANCES. By M. C. Vyvyan, M.A., D.Sc. Imperial Bureau of Horticulture and Plantation Crops, Technical Communication No. 18. Pp. 72, $10 \times 7\frac{1}{2}$. (Imperial Agricultural Bureaux. Central Sales Branch, Penglais, Aberystwyth, 1946.) Price 3*s*. 6*d*.

The use of growth substances as spray materials to control the pre-harvest fall of fruit is a new development; however, the practice is still very much in the experimental stage. Following pioneer work undertaken in the United States some ten years ago,

wide interest has arisen, and investigations have been undertaken in several countries. A practical and economic spray treatment to control premature fruit fall will be of very real value to the grower. Information on the cost of treatment, however, appears to be meagre. It will enable crops to be harvested more nearly when convenient, according to the labour and marketing situations, and will minimise the losses occasioned by high proportions of low-grade fallen fruit. Preliminary results in the United Kingdom suggest that spraying has possibilities, with the early dessert varieties Beauty of Bath, Miller's Seedling and Worcester Permain, but further work with Cox and Bramley is required before definite recommendations can be made with respect to these varieties.

At the invitation of the Imperial Bureau of Horticulture and Plantation Crops, Dr. Vyvyan has in this publication reviewed the widely-scattered literature on the subject. He discusses the general question of loss of potential crop and its causes. With deciduous fruit trees loss of blossoms and fruit is usually caused by abscission. Thereafter, he provides an exhaustive review of the experimental data that has been published, and offers practical recommendations to the grower.

Dr. Vyvyan has added one more to the steadily mounting total of useful Technical Communications issued by this Bureau.

E. H. G. S.

BOOKS RECEIVED FOR REVIEW

The Principles and Practice of Wine Making. By W. V. Cruess, Ph.D. Second Edition. Pp. xii + 476, 8 × 5½. (New York: The Avi Publishing Co., Inc., 1947.)

Raising Livestock. By Walter H. Peters and George P. Deyce. Pp. x + 519, 9¼ × 6½. (New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1946.) Price $3.50 (17*s.* 6*d.*).

The Freezing Preservation of Foods. By Donald K. Tressler, Ph.D., and Clifford F. Evers, B.S. Second Edition. Pp. xviii + 932, 8 × 5¾. (New York: The Avi Publishing Co., Inc., 1947.) Price $10.00.

The Natural Vegetation of Trinidad. By J. S. Beard, M.A., B.Sc., D.Phil. Oxford Forestry Memoirs, No. 20, 1945. Pp. 152, 10¾ × 7½. (Oxford: The Clarendon Press; London: Geoffrey Cumberlege, Oxford University Press, 1946.) Price 20*s.*

Bovine Mastitis. Edited by Ralph B. Little, V.M.D., and Wayne N. Plastridge, Ph.D. Pp. xiii + 546, 9¼ × 6½. (New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1946.) Price 35*s.*

Functional Anatomy of the Mammal. By W. James Leach. Pp. viii + 231, 9¼ × 6. (New York: McGraw-Hill Book Company Inc.; London: McGraw-Hill Publishing Co., Ltd., 1946.) Price 12*s.* 6*d.*

The Anglo-Palestine Year Book, 1946. Edited by F. J. Jacoby. Pp. vii + 384, 10 × 7½. (London: Anglo-Palestine Publications, Ltd.; Palestine: 105 Allenby Road, Tel-Aviv.) Price 25*s.*

DDT and the Insect Problem. By James C. Leary, William I. Fishbein, and Lawrence C. Salter. Pp. vii + 176, 8¼ × 5¾. (New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1946.) Price 12*s.* 6*d.*

Outlines of Paint Technology. By Noel Heaton, B.Sc., Hon. A.R.I.B.A. Third Edition, revised. Pp. xi + 448, 9 × 6. (London: Charles Griffin & Co., Ltd., 1947.) Price 32*s.*

Soil Fertility, Renewal and Preservation. By E. Pfeiffer. Revised Edition. Pp. 196, 8¾ × 5½. (London: Faber and Faber, Ltd., 1947.) Price 12*s.* 6*d.*

Bibliography of the Technical Literature on Silk. By F. O. Howitt, Ph.D., F.R.I.C., F.T.I. Pp. xxiv + 248, 8¾ × 5¾. (London: Hutchinson & Co., Ltd., 1946.) Price 21*s.*

Native Economies of Nigeria. By Professor Daryll Forde and Dr. Richenda Scott, edited by Margery Perham. Pp. xxiv + 312, 8½ × 5½. (London: Faber and Faber, Ltd., 1946.) Price 25*s.*

An African Aristocracy: Rank among the Swazi of Bechuanaland. By Hilda Kuper. Pp. xii + 251, 8¾ × 5¾. (London, New York, Toronto: Geoffrey Cumberlege, Oxford University Press, 1947.) Price 30*s.*

The Methods of Cellulose Chemistry. By C. Dorée, M.A. (Oxon.), D.Sc. (Lond.), F.R.I.C. Second Edition, revised. Pp. xii + 543, 8¾ × 5¾. (London: Chapman and Hall, Ltd., 1947.) Price 42*s.*

Concise Chemical and Technical Dictionary. Edited by H. Bennett. Pp. xxxix + 1055, 9¼ × 6¼. (New York: Chemical Publishing Co., Inc., 1947.) Price $10.00.

Imperial Preference: Its Development and Effects. Compiled by R. S. Russell, M.A. Pp. 168, 8½ × 5½. (London: Empire Economic Union, 1947.) Price 5*s.*

The Microscope: Its Theory and Applications. By J. H. Wredden, F.R.M.S. Pp. xxiv + 296, 10 × 7. (London: J. & A. Churchill, Ltd., 1947.) Price 21*s.*

Extractives from North Eastern Woods. Bulletin No. 9. Pp. 62, 9 × 6. (Connecticut: Northeastern Wood Utilization Council, 1946.) Price $1.00.

Wood Yeast for Animal Feed. Bulletin No. 12. Pp. 198, 9 × 6. (Connecticut: Northeastern Wood Utilization Council, 1946.) Price $2.00.

Path to Nigerian Freedom. By Obafemi Awolowo. Pp. 137, 8¾ × 5½. (London: Faber and Faber, Ltd., 1947.) Price 7*s.* 6*d.*

Studies in Colonial Legislatures. Edited by Margery Perham, Vol. II. The Gold Coast Legislative Council. By

Martin Wight. Pp. 285, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: Faber and Faber, Ltd., 1947.) Price 12s. 6d.

THE UGANDA JOURNAL: THE JOURNAL OF THE UGANDA SOCIETY. Vol. II, No. 1, March, 1947. Pp. vii + 67, $9\frac{1}{4} \times 6\frac{1}{4}$. (London: Geoffrey Cumberlege, Oxford University Press, 1947.) Price Shs. 7/50 (7s. 6d.).

THE CHEMICAL CONSTITUTION OF NATURAL FATS. By T. P. Hilditch, D.Sc. (Lond.), F.R.S., F.R.I.C. Second Edition. Pp. xiii + 554, $10 \times 6\frac{1}{4}$. (London: Chapman & Hall, Ltd., 1947.) Price 45s.

MODERN CEREAL CHEMISTRY. By D. W. Kent-Jones, Ph.D., B.Sc., F.R.I.C., and A. J. Amos, Ph.D., B.Sc., F.R.I.C. Fourth Edition. Pp. vii + 651, 10×6. (Liverpool: The Northern Publishing Co., Ltd., 1947.) Price 50s.

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IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY OF INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 37

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A.L.63, the Original British Army Louse Powder. By H. J. Crauford-Benson and J. Macleod. *J. Hygiene*, 1946, **44**, No. 4, 294-306. (*Bull. War Med.*, 1946, **6**, No. 11, 479-480.) The substances tested included pyrethrum and derris.

Rep. Fed. Exp. Sta. Puerto Rico, 1945. The section on insecticidal crop investigations contains information on the following: derris and lonchocarpus planting material distributed to Latin America; derris propagation; derris cutting, grafting and mulching experiments; derris physiology and chemical investigations; chemical examination of mamey seed (*Mammea americana* L.); plant toxicological studies—a number of plants showed mild insecticidal properties.

The Application of Measured Amounts of Petroleum Spray Oils to Individual Olive Scales. By E. M. Stafford. *J. Econ. Ent.*, 1946, **39**, No. 4, 499-503. In experiments carried out to increase the toxicity of petroleum spray oils to the olive parlatoria scale the addition of rotenone increased toxicity in all cases; oil containing nicotine showed no increase in toxicity.

Control of the European Corn Borer in Early Sweet Corn. By C. R. Neiswander. *Ann. Rep. Vegetable Growers' Assoc. Amer.*, 1945, 117-122. (*Amer. Chem. Absts.*, 1946, **40**, No. 20, 6201.) Effective control obtained with DDT, rotenone and ryanex either as dusts or sprays.

Insecticidal Composition. U.S. Pat. No. 2,396,054. *Soap*, 1946, **22**, No. 10, 159. Consists of a lower monohydric alcohol, light petroleum oil and an insect poison which may be pyrethrins, rotenone-containing materials or active resins such as derris.

Spray Composition. U.S. Pat. No. 2,205,394. *Brit. Absts.*, 1946, BIII, November, 247. Contains pyrethrum or rotenone.

Insecticide compositions. B.P. No. 575,413. *Brit. Absts.*, 1946, BIII, November, 247. Contains a vegetable contact insecticide such as rotenone or pyrethrum.

The Insecticide Situation. By F. C. Bishopp. *J. Econ. Ent.*, 1946, **39**, No. 4, 449-459. Includes a discussion of the position with regard to insecticide materials of plant origin.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Ann. Rep. W. Afr. Cacao Res. Inst., Gold Coast, April, 1945-March, 1946. Nicotine continued to be used in routine spraying against *Sahlbergella* and *Distantiella*, p. 6.

High Nicotine Tobacco in Australia. *Chem. Tr. J.*, 1946, **119**, No. 3100, 475. Work at Bathurst Experimental Farm, New South Wales, has resulted in the successful cultivation of *Nicotiana rustica* with an exceptionally high content of nicotine.

Des Tiflocibidos Nuevos en España que Atacan a la Vid y al Pimiento. By A. Ruiz Castro. *Bol. Pat. Veg. Ent. Agric.*, 1943, **12**, 143-189. (*R.A.E.*, 1946, **34**, A, Pt. 9, 267.) Nicotine dusts and spray of nicotine in Bordeaux mixture proved effective against nymphs and adults of *Empoasca lybica* and *E. decipiens* on vines and pimento; contact insecticides such as pyrethrum dust also recommended.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Examen Sommaire des Tiges *d'Ostryoderris lucida*. By R. Wilbaux. *Bull. Agric. Congo Belge*, 1946, **37**, No. 2, 434. Contains rotenone, but

without practical interest as an insecticide in view of the very small amount.

Manufacture of Insecticide Spray Composition. U.S. Pat. No. 2,335,862. *Brit. Absts.*, 1946, BIII, September, 193. Contains rotenone and dibutylurea.

Derris

Ann. Rep. Dep. Agric. Zanzibar, 1945. Reference to the experimental cultivation of derris, p. 15.

Situation Agricole aux Indes Neerlandaises. *Rev. Int. Prod. Colon.*, 1946, **21**, No. 199, 66. Gives figures for the area of derris planted and production of dried roots in 1944 in Java and Sumatra.

PYRETHRIN-CONTAINING MATERIALS

The Future of Pyrethrum as an Agricultural Insecticide. By J. B. Skaptason. *Agric. Chem.*, 1946, **1**, No. 5, 26-27. Despite new developments in the field of insecticides, pyrethrum continues to hold a prominent position and shows promise of maintaining its future rule.

Pyrethrum as Tsetse-Fly Repellent. Human Experiments. By J. R. Holden and G. M. Findlay. *Trans. Roy. Soc. Trop. Med. Hyg.*, 1944, **38**, 199-202. (*Amer. Chem. Absts.*, 1946, **40**, No. 18, 5525.) Anti-mosquito cream containing pyrethrum in a vanishing cream base proved of value up to at least six hours after application.

Roach Control Studies. *Soap*, 1946, **22**, No. 10, 159. Pyrethrum marc when mixed with equal parts of boric acid improved both the kill and speed of action of boric acid.

Determination of Pyrethrins Deterioration. By W. A. Gersdorff and W. F. Barthel. *Soap*, 1946, **22**, No. 10, 155-157. Solubility in dichlorodifluoromethane proved to be a good guide to deterioration.

Insecticidal Preparations [Fly Sprays]. B.P. No. 578,669. *Brit. Absts.*, 1946, BIII, November, 247. A water in oil emulsion which inverts on dilution and contains pyrethrins.

Insecticide. U.S. Pat. No. 2,332,097. *Brit. Absts.*, 1946, BIII, November, 247. Contains pyrethrum extract.

Pyrethrum Substitute. U.S. Pat. No. 2,393,999. *Soap*, 1946, **22**, No. 10, 161. N-Butyl-3, 6-endomethylene-4-cyclohexene-1, 2-dicarboxylic imide is claimed especially as a substitute for the greater part of pyrethrum in kerosene-based fly sprays.

Pyrethrum Production in Ecuador. *Chem. and Drugg.*, 1946, **146**, No. 3480, 512.

Ann. Rep. Tech. Museum, Sydney, 1945. Refers to work on Australian essential oils as insect repellents and their use as synergists in pyrethrum sprays: full report to be published shortly.

Ann. Rep. Coun. Sci. Industr. Res. Aust., 1944-45. Research programme concerned with pyrethrum curtailed owing to recent advances in the production of synthetic insecticidal materials, p. 16: spray containing 0·5 per cent. DDT and 0·03 per cent. pyrethrins caused little mortality when applied liberally to a natural infestation of cockroaches (*Blatella germanica*), p. 23.

Pyrethrum Culture Investigations in Nebraska. By A. E. Schwarting. *J. Amer. Pharm. Assoc.*, 1946, **35**, No. 10, 309-310. The results of an investigation with pyrethrum concerned with spacing, yields, pyrethrin content, etc.

Spray Killing of Mosquitoes in Houses. Control on the Gold Coast. By L. G. Eddy. *Trans. Roy. Soc. Trop. Med. Hyg.*, 1944, **38**, 167-187. (*Amer. Chem. Absts.*, 1946, **40**, No. 18, 5525.) Pyrethrum aerosol constitutes the insecticide of choice; pyrethrum-kerosene is next best in order of labour economy.

Experiments on the Synthesis of the Pyrethrins. Part II. The Structure of Cinerone. By S. H. Harper. *J. Chem. Soc.*, 1946, October, 892-894.

Raw Material Markets. *Soap*, 1946, **22**, No. 11, 61. Peru's Ministry of Agriculture authorised to acquire the pyrethrum crop up to a value of 10,000 soles.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Black Pepper to Control the Bean Weevil. By F. H. Lathrop and L. G. Keirstead. *J. Econ. Ent.*, 1946, **39**, No. 4, 534. Black pepper may have value for the protection of home-stored beans from attacks of weevils.

Ryania Insecticides. U.S. Pat. No. 2,400,295. *Amer. Chem. Absts.*, 1946, **40**, No. 20, 6206. Extracts or concentrates from a number of species of *Ryania* contain alkaloids which have pronounced insecticidal properties.

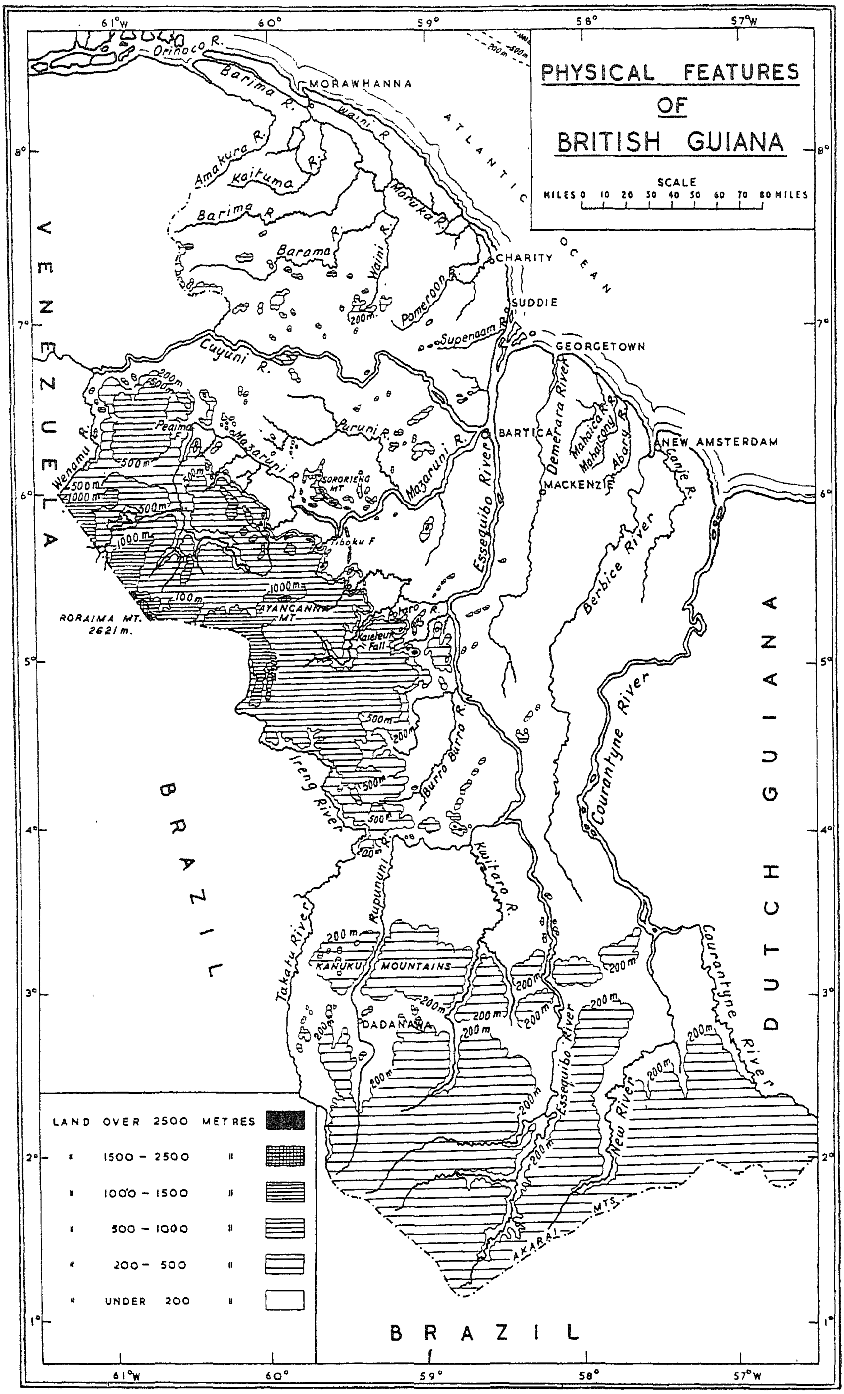
Insecticide. U.S. Pat. No. 2,333,061. *Brit. Absts.*, 1946, BIII, September, 193. Based on *Ricinus communis.*

Sabadilla Insecticide Development. *Soap*, 1946, **22**, No. 9, 135, 137.

Sweet-rush (*Acorus calamus* L.)—A New Antipediculous Substance. By B. B. Rubinshtein. *Med. Parasitol.*, 1945, **14**, No. 2, 72-73. (*R.A.E.*, 1946, **34**, B, Pt. 11, 182.) Describes tests carried out with the dried rhizomes and leaves against lice (*Pediculus humanus*).

Costa Rica's New Insecticide. *Foreign Comm. Wkly*, 1946, **24**, No. 13, 32. Known as " Segurol 80-33," has been made from a plant known locally as " coyolillo " and in the U.S. as " nut grass."

PLATE I.



PHYSIOGRAPHIC MAP OF BRITISH GUIANA.

MINERAL RESOURCES

ARTICLE

THE GEOLOGY AND MINERAL RESOURCES OF BRITISH GUIANA

By SMITH BRACEWELL, B.Sc., A.R.C.S., D.I.C.
Director, Geological Survey Department of British Guiana

BRITISH GUIANA is situated on the northern coast of South America between Venezuela, Brazil, and Dutch Guiana and covers an area of about 85,000 sq. miles. The bulk of its population of 367,000 is dependent on agricultural industries and is confined mainly to the narrow coastal plain and the estuarine banks of the main rivers. The interior of the Colony is sparsely populated by indigenous American Indians and by itinerant gold and diamond miners, as well as by balata seekers, timber workers and, in the southern part, cattle ranchers. There are, however, three important bauxite-mining centres; also a number of settlements and trading stations in the gold and diamond mining areas.

Until recent years, the chief means of access to the interior was by way of the large rivers, but in 1934 a natural-surface motor road was constructed from Bartica to the Potaro Goldfield, a total distance of 115 miles, with a diversion at Mile 70 to Issano Landing on the Mazaruni River. A cattle trail, 160 miles long, connects the Rupununi savannahs with the navigable portion of the Berbice River. Latterly, increasing attention has been given to the potentialities of air-transport as a means of access to the interior. The chief airport in British Guiana is at the U.S.A. Base, Atkinson Field, Hyde Park, Demerara River. This is used by landplanes flying to and from other countries and by those of British Guiana Airways Co., Ltd., making flights to interior landing strips situated at Lethem (the new name for Bon Success), Wichabai, and Lumipau (situated about 20 miles N.W. of Marudi Mountain), and at Mahdia River, Potaro. The Mackenzie Airport is not being used at present. There are other small airstrips at Imbaimadai and Chi-Chi Falls in the upper Mazaruni district, at Ebini, Berbice River, at Orinduik Fall and Karasabai near the Ireng River, and at Karananbu and Parabaru and other localities in the Rupununi savannahs. With the help of Government subsidies, the flying boats and amphibians of British Guiana Airways operate between the Demerara River, Georgetown and numerous recognised landings on rivers in the

interior. Regular air services are run to the Mazaruni and Rupununi districts and it is possible to charter machines for flights to almost any part of the interior where landings on the rivers are possible.

The Cuyuni Goldfields Co. has a seaplane operating between the Demerara River and Aurora Landing, Cuyuni. A landing pool about 2,000 ft. long was recently constructed by damming a small creek at Baramita, Barama River, and this has been used by a British Guiana Airways flying boat. A landing field has been partially constructed near Aurora Mine, Cuyuni, but construction work has been temporarily discontinued.

Physical Features

Pakaraima Mountains

A broad belt of mountainous country, known as the Pakaraima Mountains, extends east-south-east across the northern half of the Colony from its boundary with Venezuela and Brazil to the Berbice River. The highest point is Roraima Mountain, a plateau about 2,000 ft. high, and about 8,600 ft. above sea-level, which forms the common boundary of the Colony with Venezuela and Brazil. The Pakaraimas consist mainly of a series of plateaux or mesas of varying altitude and terminate north-eastward in a long, irregular escarpment 1,000 to 3,000 ft. high, which runs roughly parallel to, and 140 miles distant from, the coast-line.

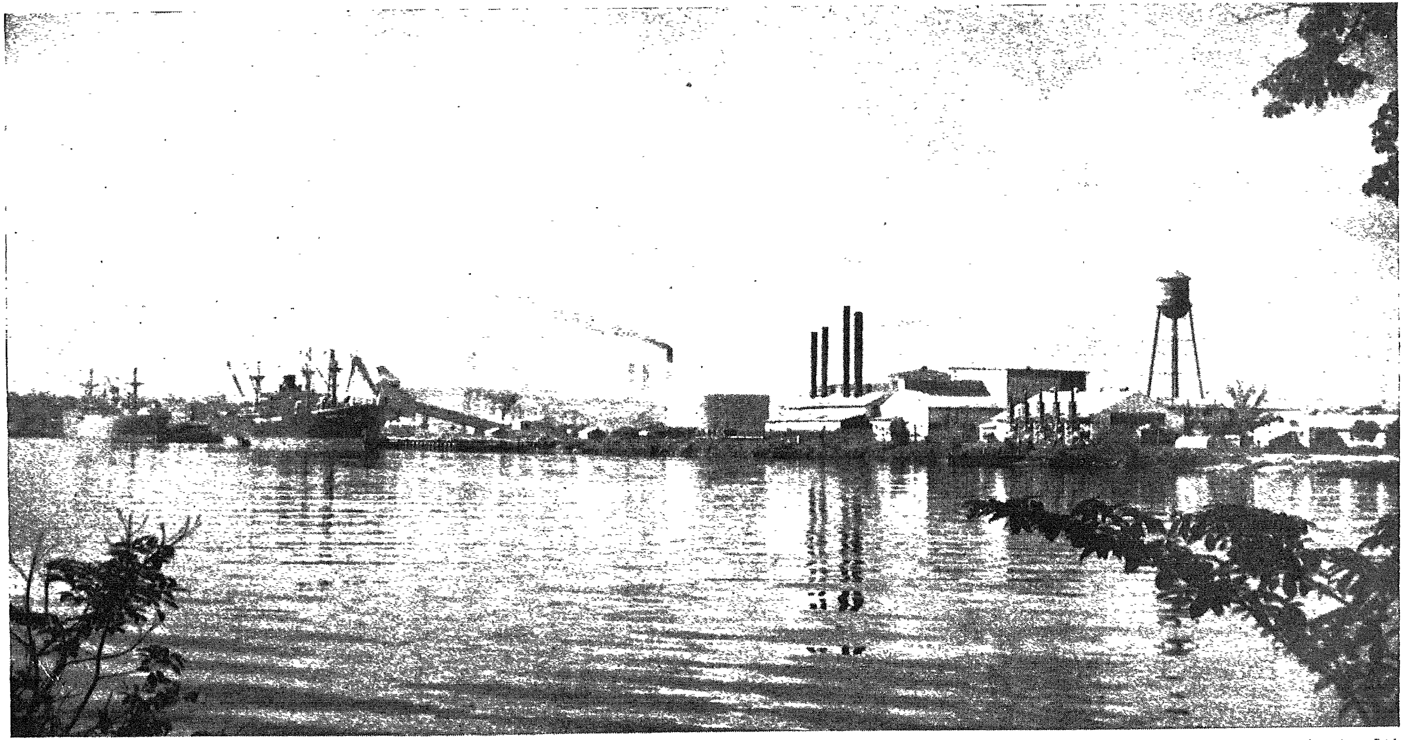
The plateaux consist of sandstone, conglomerate and shale of the Kaieteurian Sedimentary (or Roraima) Formation, and, except in the vicinity of rivers, are comparatively bare of vegetation. The sedimentary formation, however, has been intruded by huge sills of gabbro, and, where these are exposed, the country is usually forest-covered and has a more rugged aspect. There are numerous Indian settlements in the savannahs of this elevated region.

Savannah Mountains

South of a line joining the Echilebar and Siparuni rivers the sandstone plateaux give place to a more rugged region, referred to by C. Barrington Brown as the Savannah Mountains, which appears to consist mainly of foliated volcanic rocks.

White Sand Region

As will be observed from the accompanying physical map of British Guiana, most of the area north of the Pakaraima Mountains is below the 200-metre contour. There are a few isolated hills rising above this level and these tend to form chains with a general north-easterly alignment. The hills consist mainly of metamorphic rocks with their argillaceous and lateritic weathering products. Between these chains of hills there are broad belts of sandy country which gradually widen towards the coast. These are formed mainly of a series of stratified sands and clays which were deposited in the sea or in the broad estuaries or deltas of rivers. Recent



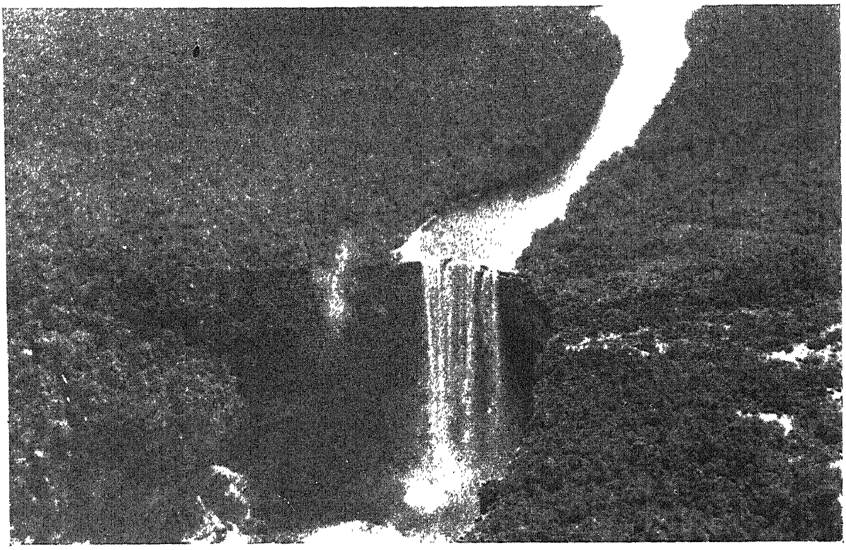
[*By courtesy of the Demarara Bauxite Co., Ltd.*

MACKENZIE, DEMARARA RIVER.

View of bauxite plant area showing the diesel power-house (to the left of the water tank), the four stacks of the steam power-plant, and the stacks from the kilns (in centre). The two large ships at the extreme left are at boat loaders Nos. 1 and 2, and between these ships is a small tanker.

[*facing page* 48

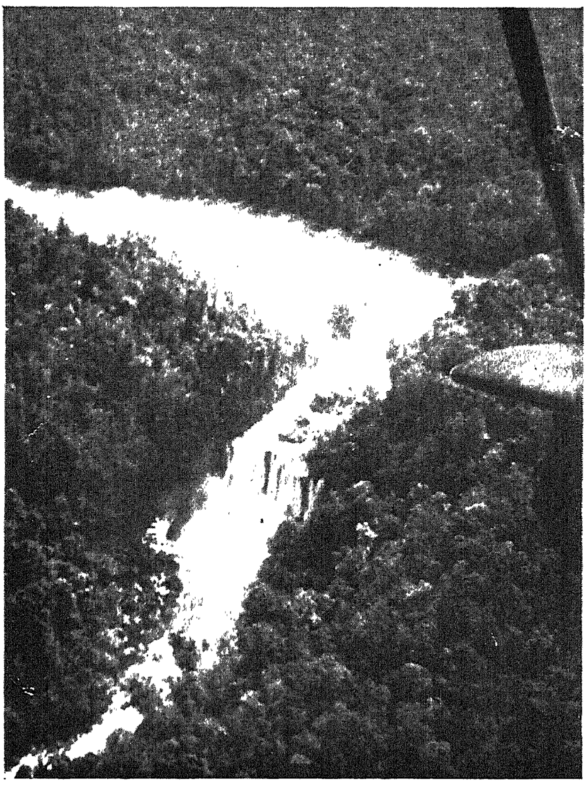
PLATE III.



KAIETEUR FALL, POTARO RIVER. [*Photo: S. Bracewell*

Estimated height, 841 ft. Estimated width, 370 ft.

PLATE IV.



elevation of the region has led to erosion and partial removal of these fluvio-marine deposits by the large rivers and their tributaries, and they are now mainly confined to the watersheds between the main rivers. They form a dissected, gently undulating, plain with a general inclination to the north-east from a height of about 400 ft. above sea-level near the Kaieteurian escarpment to about 100 ft. near the coast. This low sandy region extends southward around the eastern and southern flanks of the Pakaraima Mountains and may cover much of the southern part of the Colony, where, in the vicinity of Marudi Mountain, it appears to reach a level of about 850 ft. above sea-level. The vegetation on this sandy area shows considerable variation; in the northern part of the Colony much of it is covered by tropical forest, but this may give place to low "muri" scrub, palm swamps and grass savannahs; in the southern part of the Colony, in the vicinity of the Rupununi River, there are extensive areas of low savannah suitable for cattle rearing. It is possible that the whole of this low region was recently inundated.

Kanuku Mountains

A broad belt of rugged country with numerous peaks rising to about 2,500 ft. above sea-level, and known as the Kanuku Mountains, extends roughly east-west across the southern part of the Colony. The hills are almost completely forest-covered and consist mainly of metamorphic rocks.

The Coastal Plain

The White Sand region described above terminates a short distance from the coast-line in a series of hills about 100 ft. high. Between these hills and the sea there is a coastal plain of varying width which has been formed by recent accretion. Much of this area is below the level of high tides and is protected from inundation by various forms of sea defences. It is drained by trenches which discharge into the sea at low tide and is irrigated by canals from a series of lakes and conservancies occurring at the junction of the coastal plain and the sandy region. The coastal plain is contiguous with the continental shelf which extends seaward for a distance of about 100 miles.

Geology

Three broad geological divisions are usually recognised, namely:

Superficial Formations;
Kaieteurian Sedimentary Series;
Older Basement Rocks.

The Basement Rocks comprise gneisses and schists, and a series of metamorphosed extrusive and sedimentary rocks, usually grouped together under the name of the Volcanic Series. These are intruded by granitic batholiths and their apophyses and by a later series of gabbroic intrusions extending upwards into

the overlying Kaieteurian. The Superficial Formations consist of some thousands of feet of unconsolidated sediments, known locally as the Coastal Sedimentary Series, and their inland equivalent, the White Sand Series, along with more recent alluvial deposits and residual formations.

The surface of the Basement Rocks attains its greatest known elevation of about 2,500 ft. in the Kanuku Mountains and has a general northerly, or north-easterly, inclination, finally becoming completely concealed beneath the coastal sediments some distance from the present coast-line. The surface is somewhat irregular, being probably the remnant of an old peneplain. It is fairly flat, but there are numerous ridges and chains of hills projecting above the general level of the White Sand Series and having a general north-easterly alignment; these are considered to represent the watersheds of an ancient drainage system. This peneplain was partially inundated, and the lower parts of it were covered by the Coastal Sedimentary and White Sand Series. As a result of a subsequent uplift of some hundreds of feet, or to a tilt of the region, the White Sand Series was elevated above sea-level and now forms an extensive dissected sandy plain covering the lower parts of the Colony.

The rocks of the Kaieteurian Sedimentary Series are of an age intermediate between those of the Basement and the Coastal Sedimentary Series and are now restricted mainly to the extensive plateaux of the Pakaraima Mountains; it is assumed, however, that they formerly extended northwards over the crystalline Basement and the writer has suggested that the consolidated sediments recently encountered in the drilling of a deep well in the coastal portion of the Berbice District may be part of this series.

Superficial Formations

Alluvial Deposits

The coastal plain is formed of a recent deposit of marine alluvium consisting of a bluish-grey silty clay with lenses of sand and shell and accumulations of peaty or vegetable material known locally as "pegase." This deposit is about 200 ft. thick. It extends inland along the banks of the estuaries of the rivers forming a trough about 100 ft. deep beneath the flood plain of the Demerara River.

The lower parts of the Colony have received much alluvium since the emergence of the White Sand Series. Much of the latter has been eroded and redistributed, together with material derived from the hills, in the form of terraces and alluvial deposits. In the larger rivers the alluvial deposits are some 18 to 30 ft. thick and hundreds of feet wide, with terraces on their banks of equal thickness. The rainfall is heavy in this region and there are thousands of small streams with alluvial deposits and terraces of varying thickness, often grading upwards into a mantle of eluvial

material on the adjacent slopes. These have been extensively worked for gold and diamonds.

In the Pakaraima Mountains, also, there are extensive alluvial flats and sandy terraces.

Residual Deposits

Clays.—Sub-aerial weathering processes have penetrated deeply into the surface of the older rock formations of British Guiana, converting the granitic and gneissose rocks into sandy kaolinic clays and the metamorphic rocks of the Volcanic Series into clays of variable colour.

Laterite.—There are large areas of ferruginous laterite which occurs typically as continuous deposits some 6 to 20 ft. thick lying on, or in proximity to, the hills that rise above the surface of the White Sand Series. The surface of the laterite is often nearly level or has a slight inclination away from the hills and may merge downwards into the surface of the White Sand. It forms a series of " benches " around the more rugged areas, and a more or less continuous " selvedge " between the hills and the White Sand regions. These benches have been considered to represent parts of the surface of an old peneplain, now gradually being broken down by weathering and erosion processes. The laterite often contains a little gold, which is largely in the surface layers, the hill slopes below the laterite benches being covered by a few feet of sandy or clayey lateritic gravel in which the gold values may be sufficiently high to permit of profitable working. On reaching the streams the lateritic gravel tends to disappear, and gold values are much higher in the alluvial deposits. Lateritic soils are characteristic of most of the alluvial gold mining areas of the Colony.

Bauxite.—The investigations carried out by geologists of the Demerara Bauxite Company indicate that the bauxite has originated *in situ* by decomposition of the underlying Basement Rocks, which are mainly of an acidic nature, and from which the bauxitic deposits are separated by a variable thickness of kaolinic residual clays. The configuration of the bauxite surface conforms to that of an old land surface of moderate relief (of the order of several hundreds of feet) and, in general, the deposits have the shape of " turtle-back " ridges or domes. They vary in thickness from a few up to 40 ft., and the ore is essentially a tri-hydrate of alumina, generally white, pink, or light brown in colour, depending on the amount of iron present. Erosion, percolation, and re-cementation have produced a layer of low grade bauxite on top of some of the deposits, and there is generally an uppermost thin layer of rounded bauxite pebbles resulting from erosion of the deposits prior to deposition of the overlying sediments.

The bauxite deposits of British Guiana lie within a comparatively narrow belt running approximately north-north-west from Kwakwani on the Berbice River to the mouth of the Essequibo

River. They occur as cappings on an old land surface, now generally buried beneath the sediments of the White Sand Series, and are exposed only where recent erosion has removed these sediments. The belt within which the bauxite deposits lie has no apparent relationship to the dominant structure of the underlying Basement rocks, but appears to have some relationship to the line joining the points of emergence of the crystalline Basement from beneath the Coastal Sedimentary Series. Pebbles and small boulders of bauxite occur within the laterite and White Sand areas to the south-west and west of this belt. The ferruginous laterite is occasionally honeycombed with pink gibbsitic material and white crystalline gibbsite.

Information regarding the discovery of bauxite and the development of the industry is given on p. 60.

Coastal Sedimentary and White Sand Series

Beneath the coastal alluvium there is a succession of more or less stratified white sands, clays and gravels with occasional seams of lignite. In the north-west these are only 330 ft. thick, but south-eastward along the coast they gradually thicken and reach their maximum known thickness of 6,300 ft. at the mouth of the Berbice River. They are generally unconsolidated, but in the Berbice region the deposits become more compact below a depth of 4,400 ft. Inland, also, they gradually thin out against the sloping surface of the crystalline Basement, which gradually approaches the surface and is exposed some 20 to 60 miles up the main rivers. Between the main rivers, and forming the White Sand region previously described, there is a stratified succession of white, yellow, and red sands, quartz gravels, light grey or reddish clays and peaty sands with occasional seams of lignite. These have been described by Dr. D. R. Grantham under the name of the "White Sand Series." They are generally similar to the coastal sediments, however, and are regarded as a portion of the same formation which owes its present position to a recent uplift or tilt of the region.

The exposed sand beds are regarded as the outcrops and catchment areas of the aquifers of the Coastal Sedimentary Series, from which supplies of artesian water are obtained at numerous points along the coast-line. These sediments have been deposited in the sea or in the estuaries of large rivers which formerly covered the White Sand Region, and buried the peneplain that previously existed on the crystalline Basement.

The deposits of the White Sand Series are well exhibited in some of the bauxite mines, where they form an overburden up to 100 ft. thick, though their maximum thickness is probably a good deal more. In the vicinity of the Pakaraima Mountains the deposits tend to become coarser and probably contain diamonds. The

diamond-bearing alluvial deposits are very largely confined to White Sand regions.

The only evidence regarding the age of the series is afforded by the occurrence of arenaceous foraminifera transitional between species that occur in sub-recent lagoonal deposits and the lignitic facies of Miocene and Pliocene age in Trinidad, which were reported to have been found in the drilling of the Rose Hall test well. They were probably derived from the shaly lignitic clay between 4,160 and 4,200 ft. Leaf impressions are occasionally found in laminated grey clays and in the laminated hæmatite and limonite of the White Sand Series.

Kaieteurian Sedimentary Series or Roraima Formation

The Kaieteurian Series consists of stratified pink, yellow and white sandstones; reddish quartzites and jaspers; green, red, and black shales and hornfelses; conglomerates; and boulder beds. It forms much of the northern part of the Pakaraima Mountains and occurs in the outlying Maccari Mountain and Parish's Peak near the Berbice River. It is reported to cross the Essequibo River in a long narrow belt at Comuti and Twasinki Mountains, the Berbice River near Marlissa Rapids, and the Courantyne River at Cabalebo River and near Akalikatabo Island. The writer has suggested that the bed of conglomerate that was encountered in the Rose Hall test well 1,000 ft. above the Basement may possibly be correlated with this series.

The formation attains its highest known level on the summit of Roraima Mountain (8,600 ft.). Its base in the Ireng River is at 1,400 ft. Its true thickness is not clear as it is intruded by immense sills of gabbro and is possibly step-faulted.

No fossils have ever been found in the formation, and its age is uncertain. It has been compared with the Torridonian Sandstone, with Devonian, Permian and Triassic formations of Brazil, and has been tentatively correlated with the La Quinta Formation which occurs near the Venezuelan and Columbian Andes, and with deposits of Jurassic and lower Cretaceous age exposed along the Venezuelan Coast Range.

The greater part of the Kaieteurian has a horizontal disposition, and it has been observed that this is more particularly the case where the sediments rest directly on granitic rocks. It is often tilted, however, and in the section between the Karanang and Merume rivers, where the formation is underlain by shales, phyllites and volcanic rocks, there is evidence of severe folding along a synclinal axis running roughly north-north-east. This folding is probably related in origin to the intrusion of the newer basic rocks. The underlying shales and volcanic rocks may have been dynamically metamorphosed as a result of these movements. Other evidence also indicates considerable deformation of the Kaieteurian Series

and folding along axes roughly at right angles to the general trend of the escarpment.

Newer Basic Intrusives

Gabbro is exposed over large parts of the Pakaraima Mountains, and occurs in the form of sills hundreds of feet in thickness intrusive into the Kaieteurian Series and the underlying Basement. The sills form characteristic scarps and dip slopes, and project north-eastwards from the Pakaraima Mountains forming long ridges and dissected basins and domes. The gabbro is often coarsely ophitic, but immense areas are covered by a noritic gabbro of uniform composition and texture, consisting of large stumpy prismatic crystals of hypersthene with a finer grained interstital aggregate of plagioclase felspar. The ophitic gabbros contain a variable amount of fine-grained interstitial quartz and felspar with a micrographic texture. Numerous dykes of ophitic dolerite traverse the Basement, and a few penetrate the Kaieteurian Series. They have a dominantly north-east trend and can often be traced for long distances. Some of them appear to terminate abruptly against the newer granitic intrusives.

Crystalline Basement Rocks

The crystalline Basement consists of metamorphic and intrusive rocks of acid and basic composition. The older metamorphic members may be coarse-grained gneisses or finer-grained schists, and the latter grade into the foliated rocks of the Volcanic Series.

In the southern part of the Colony the dominant foliation-trends are north-north-easterly with subsidiary foliation-strikes at right angles. This dominant north-north-easterly or north-easterly strike extends northwards of the Kanuku Mountains into the north-eastern section of the Colony. In the north-westerly section, however, the dominant foliation-strikes trend west-north-west, roughly parallel to the central axis of the Pakaraima Mountains, the Kaieteurian scarp and the courses of the Mazaruni, Cuyuni, Barama and Barima rivers. The period of deformation is generally assumed to have been pre-Kaieteurian, but the folding in the Kaieteurian referred to in a previous section, along axes roughly parallel to the dominant north-north-east foliation of the Basement, suggests that some of this foliation may have been the result of post-Kaieteurian diastrophism contemporaneous with the intrusion of the newer basic rocks.

Volcanic Series

Before the deposition of the Kaieteurian sediments there was a period of volcanic activity, during which a great thickness of extrusive rocks and sediments was accumulated. Subsequently these deposits were subjected to powerful earth movements which crushed and sheared them. The series is now represented by

foliated agglomerates, tuffs and lavas, and by finer grained horneblende-, chlorite-, and sericite-schists, phyllites and quartzites, etc. They may be correlated with the Pastora Series of andesites and basaltic tuffs of the El Callao Goldfield of Venezuela, and they have a general similarity to the Upper Birrimian Series of the Tarkwa district of the Gold Coast as described in publications of the *Gold Coast Geological Survey*. In the area north of the Pakaraima Mountains the planes of schistosity have a dominant west-north-west alignment, roughly parallel to the Kaieteurian scarp, but in the southern part of the Colony and in the lower Cuyuni and lower Barama region, the dominant strike is north-easterly.

Upwards, the series grades into violet shales and phyllites, often referred to as the Haimarakka or Itawah Series, which occur along, or close to, the base of the Kaieteurian escarpment and which may form a part of the Kaieteurian Series.

The Volcanic Series has been intruded by batholiths of granite, and by smaller bodies of aplite, pegmatite, porphyry and diorite, and by dykes and sills of dolerite and gabbro. The chief goldfields of the Colony are located on, or in proximity to, the volcanic rocks, particularly along their contacts with granitic intrusions. Deposits of manganese ore occur in the lower Barama region near similar contacts.

Gneisses and Schists

There are large areas of strongly foliated gneiss and schist, more particularly at places remote from the Kaieteurian Series, from which they are possibly separated by the intervening extrusive and sedimentary rocks of the Volcanic Series. They are of variable composition and include granitic gneiss, hornblende- and biotite-gneiss, amphibolite, and pyroxene granulite. The last-named occurs in the Kanuku Mountains along with granitic gneisses with a good deal of garnet. In this area, and farther south near Dadanawa, the gneisses contain bands of a dark grey to black garnetiferous pseudo-tachylite. The gneisses merge into finer grained sericite-, chlorite-, talc-, hornblende-, staurolite-, and kyanite-schists, as well as into phyllites and into the foliated Volcanic Series. No clear delimitation of these has yet been found practicable. Specimens of these rocks have been presented to the Imperial Institute for reference purposes and comparison with those from other Colonies, and it is hoped to add to them, in the future, as better material comes to hand. Generally speaking the gneissose areas are poor in gold and other economic minerals, but near the coast they may have been converted by weathering into commercial deposits of bauxite or kaolin.

Much of the stone used for road metal and constructional purposes in the coastal area consists of gneiss, granite and pegmatite

quarried from outcrops in the lower parts of the Essequibo and Demerara rivers.

Mining Industries

Between the years 1884 and 1945, minerals of a total value of about 153 million dollars (B.W.I.), equivalent to about £32 million sterling, were produced from British Guiana. The maximum value of the minerals produced in a single year was nearly 12 million dollars (nearly £2½ million) reached in 1943, when, owing mainly to the abnormal amount of bauxite produced, the value of minerals exported from the Colony was, for the first time on record, slightly greater than the total value of all other exports of domestic produce. In the years 1938 and 1944, however, minerals accounted for roughly one quarter of the total value of exports of domestic produce.

The mineral production figures for 1945 are as follows :

Quantity.			Value.	
			$ (B.W.I.).	£ sterling.
Gold	*oz.*	22,533	741,331	154,444
Diamonds	*carats*	15,442	459,708	95,772
Bauxite	*long tons*	738,544	4,431,264* (approx.)	923,180 (approx.)

* *Calculated at* $6.00 *per long ton*

The only minerals that have been exported up to the present are gold, bauxite, and diamonds ; the history, present position, and future prospects of these are briefly described in the following sections.

Gold

Between 1884 and 1945, 3,118,970 oz. of gold, valued at about $58 million (£12,283,100), were produced and exported. The maximum production in a single year was 138,527 oz. worth $2,424,237 (£505,049) in the year 1893-94. Subsequently, production declined steadily to 6,083 oz. in 1928. Consequent upon the increase in the value of gold about 1933, and the development of dredging operations, there followed a slight revival of the industry and by 1938 annual production had increased to 41,919 oz. During the war, however, production again declined to 18,986 oz. worth $611,894 (£127,478) in 1944, but there was an increase in 1945 to 22,533 oz., valued at $741,331 (£154,444).

Of the 3 million oz. of gold produced, it is estimated that only about $\frac{1}{15}$ has been produced by dredging, about $\frac{1}{13}$ by quartz

milling, and $\frac{1}{70}$ by large-scale hydraulicking. The bulk has been recovered by small-scale hand methods from thousands of small workings by means of the battel, "tom," chest, and sluice, and by hand-operated crushing devices, known locally as "denkies." The situation of these workings is indicated on the accompanying mineral map, and it will be observed that they are widely distributed over the northern part of the Colony, and that only one comparatively small goldfield, Marudi Mt., has yet been found in the southern part of the Colony.

Dredging

Approximately 200,000 oz. of gold have been recovered by dredging operations in the Colony. Between 1907 and 1910 there were five dredges working in the Konawaruk and Minnehaha rivers, and in 1914 an additional dredge was erected in the Mahdia River. Dredging has been carried out in the Omai District and an unsuccessful attempt was made to dredge the Barima River below Arakaka. In 1923 a dredge was imported to work the Aranka River, Cuyuni District, but was never erected. The only dredge working at present is that erected in 1936 by the British Guiana Consolidated Goldfields Co., Ltd., to work an area previously recommended by the Geological Survey. Between July, 1937, and November, 1942, the total yardage dredged was 4,843,235 cu. yd. from which 40,616 oz. of gold were obtained, an average recovery of 4·02 grains per cu. yd. worked. The dredge treats approximately 1 million cu. yd. per year at a field cost of about 7 to 8½ pence per cu. yd. (*see* Plates VII and VIII).

Large deposits of dredgeable ground have been proved to exist in the Potaro River near Tumatumari and in previously dredged parts of the Konawarku River, and these may be worked as soon as the necessary equipment becomes available. A number of unsuccessful attempts have been made to use slack-line scrapers for working deposits of insufficient volume to warrant the installation of dredges. Equipment consisting of a monitor and gravel pump has been used with some success during recent years to work residual gold deposits in the Barama River region.

Dredging operations have been largely confined to the Omai-Potaro-Konawaruk region, but there is no apparent reason why they should not be applied in other goldfields, and there is a need of further exploration with this in view.

Hydraulicking

Large-scale hydraulicking operations were carried out at the Omai Mine between 1902 and 1908, and a total of some 35,000 oz. of gold is reported to have been recovered. The material worked consisted of eluvial lateritic gravel and residual clays, derived from a broad dyke of aplite, and was followed to a depth of about

150 ft. It is reported that in 1904-05 the gold recovery from this material averaged from 25 to 35 pence to the cu. yd., and that it was worked at the rate of 3,000 yd. per day.

At Tassawinni, Barama River, 11,244 oz. of gold were recovered between 1907 and 1914 by the hydraulicking of residual clays derived from sheared volcanic rocks and phyllites impregnated with minute stringers of quartz. Average recoveries are reported to have been 10·8 grains (17½ pence) per cu. yd.

Mining and Milling

According to the Annual Reports of the Lands and Mines Department the total amount of gold declared as derived from quartz milling operations between 1894 and 1916 amounted to 69,430 oz. The chief producers were the Peter's Mine (40,228 oz.), Barima Mine (16,559), Winter Mine (2,191), Barr Robertson (2,120), Gates Mine (986), Sir Walter Raleigh (79), Aremu Mine (6,531), and Kanaimapoo (756).

During recent years mining and milling operations have been conducted at Baramita, Noseno, and Ianna in the Barama area; at Tamakay, Eldorado Mine and Tikwah Mine in the Mazaruni District; and at Aurora Mine near the Cuyuni River. The largest operations at present are those at the last-named locality. During 1939 an outcrop of ore running about 1¾ oz. to the ton was discovered on the crest of Alec Hill. The deposit was subsequently worked by open cut and underground methods, two levels being driven some 90 ft. and 150 ft. below the crest of the hill. Since 1940 a ball mill of 50 tons daily capacity has been in operation and recently a cyanide plant has been installed. Between the 28th May, 1940, and July, 1945, 23,282 oz. of gold were recovered from the mine. The average recovery by amalgamation is reported by the company to have been roughly 0·3 to 0·4 oz. per ton, and to have represented only a 30 per cent. to 50 per cent. recovery. A more satisfactory recovery was obtained after the installation of the cyanide plant. From 1st April to 31st July, 1946, production was 2,955 oz. of gold from 4,555 tons of ore, averaging 0·759 oz. of gold per ton. Mining has so far been confined to ore situated above the water table. The ore is highly weathered and consists of a somewhat friable aggregate of quartz and limonite. The mineralised zone, which is about 1,000 ft. long and some 10 to 60 ft. wide at the surface, runs north-north-west and consists, above the water table, of clays and sandy clays of variable colour. Some of these display foliation, and the dominant strike of this is parallel to the regional strike of the foliated volcanic rocks and phyllites exposed in the Cuyuni River, namely 300° magnetic. The ore-shoots and some of the quartz veins have a similar alignment: they occur *en échelon* within the mineralised zone and alternate with bands of barren clay.

The country rocks in the vicinity of the mine are greyish-green foliated volcanic rocks and grey phyllites with dominant west-north-westerly foliation strikes, intruded by slightly sheared dykes of a white porphyry and dark green diorite. These are situated near the north-eastern margin of a granitic batholith which runs roughly parallel to and about a mile distant from the mineralised area. The batholith consists of massive porphyritic granite with a little hornblende, biotite and chlorite; pink granite porphyry and aplite; and a series of tough, fine to medium-grained hornblendic rocks (epidiorite, quartz diorite or hornblendic granophyres). Coarse gold occurs in alluvial deposits on the batholith, notably in proximity to the dioritic rocks. The latter may occur as dykes or pseudo-dykes (xenoliths) in the marginal portions of the batholith and may be the product of assimilation of the country rocks, or of differentiation.

Diamond drilling has proved the existence of a workable body of auriferous sulphides in quartz veins in the rock formation beneath the oxidised zone and at a depth of 130 ft. below the second level. The veins traverse a light greenish-grey carbonated schist, and the Company reports that the drill core between 350 and 358½ ft. assayed 0·64 oz. of gold to the short ton, and 1·53 oz. between 370 and 373 ft. Values of 0·05 to 0·08 oz. were obtained in the 11·5 ft. of waste between these two zones. A shaft is being sunk from the second level.

Recent developments at the Aurora Mine have served to attract the interest of a number of Canadian and American mining concerns in the possibilities of the existence of similar ore-bodies in other parts of the Colony and a great deal of exploration work has recently been undertaken. The possibility of the discovery of new goldfields in the northern part of the Colony is remote as the area has already been widely prospected. There are more hopeful possibilities in the southern part of the Colony, which has hitherto received less attention owing to its inaccessibility and the high cost of transport to this area. The Savannah Mountains, which lie south of a line joining the Echilebar and Siparuni rivers and which consist largely of rocks of the Volcanic Series, may be a fruitful field for exploration. Mention should also be made of the possibility of the occurrence in the Potaro District of mineralised rock masses. The late Sir John Harrison[1], for instance, referred to mineralised masses of porphyry, aplite, granitite and granophyre, and reported that "The mean contents of the samples examined in the Government Laboratory were sixty-five pennyweights of gold and twenty-three pennyweights of silver per ton of the ore, but the proportions varied widely in particular samples—from thirty-one grains to three hundred pennyweights of gold, and from twelve grains to one hundred and fifteen pennyweights of silver."

[1] *The Geology of the Goldfields of British Guiana*, by J. B. Harrison; London, 1908, p. 190 *et seq.*

Bauxite

The occurrence of bauxite in British Guiana appears to have been first recognised and recorded in the year 1910 by the late Sir John Harrison, former Director of Science and Agriculture and Government Geologist, when an analysis of the material found at the old Government rubber experimental station at Christianburg, Demerara River, was published in the *Official Gazette of British Guiana*. It should, however, be mentioned that Mr. Charles Barrington Brown had previously reported the occurrence of "lumps of a reddish-white friable pisolitic rock" not far from the Demerara River.[1]

In 1917, 2,037 tons of crude bauxite was exported from Akyma; since then and up to the end of 1945, 9,320,412 tons of the ore, valued at approximately $53 million (£11 million), has been exported from the Colony. In 1938 the production of bauxite was 376,368 tons valued at $1,896,913. During 1943 production reached its maximum of 1,901,393 tons valued at $10,899,895 (£2,270,811).

The deposits vary in size from a few hundred thousand tons to several million tons. Up to the present, mining has been entirely by opencast methods and has been restricted to the more or less flat-topped portions of the deposits forming the crown of the "turtle-backs" or domes in which they occur, and to those deposits that lie largely above water-level or under less than 100 ft. of overburden. The known deposits vary in elevation from 100 ft. below to 200 ft. above sea-level, the highest being those at Ituni which are located on and near the Demerara-Berbice watershed. The most extensively worked deposits are situated within a few miles of Mackenzie on the banks of the Demerara River.

The ore is washed and dried at Mackenzie (*see* Plate II), the bulk of the material being shipped to the aluminium plant of the Aluminum Company, of Canada, Ltd., at Arvida, Quebec. The ore mined at Kwakwani, Berbice River, is washed and screened on the spot, and then transported down the Berbice River to Everton, where it is dried and stored for shipment to the United States.

The future of the Colony's bauxite mining industry is likely to be dependent upon three chief factors, namely: the reserves of ore in the Colony in relation to the world position; the future of the aluminium and other industries which use bauxite; and the possibility of metallurgical developments which might affect the demand for bauxite. The figures supplied to Government regarding the bauxite reserves of the companies operating in British Guiana are not available for publication. There appears to be general agreement that the demand for bauxite will, however, continue to increase beyond the pre-war level, and there is reasonable hope that the bauxite industry of the Colony will be maintained for many years. It has frequently been suggested that some or all of the

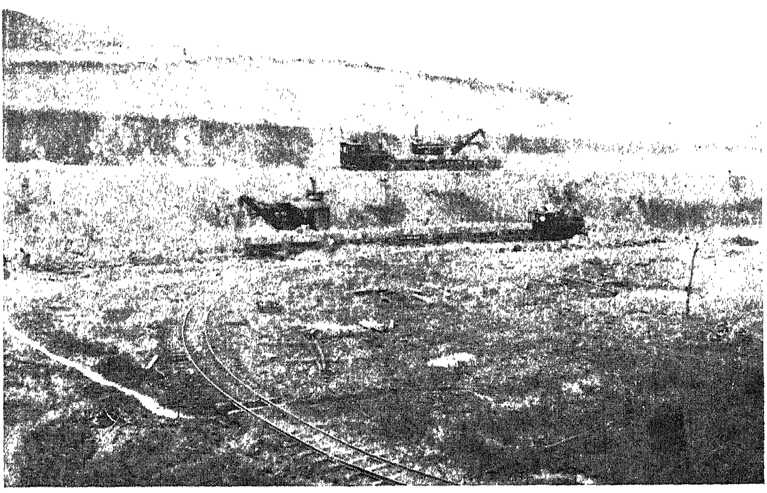
[1] *Reports on the Physical, Descriptive and Economic Geology of British Guiana*, by C. B. Brown and J. C. Sawkins; London, 1875, p. 247.

PLATE V.

[By courtesy of Aluminium Union Ltd.

BAUXITE MINING IN BRITISH GUIANA.

PLATE VI.

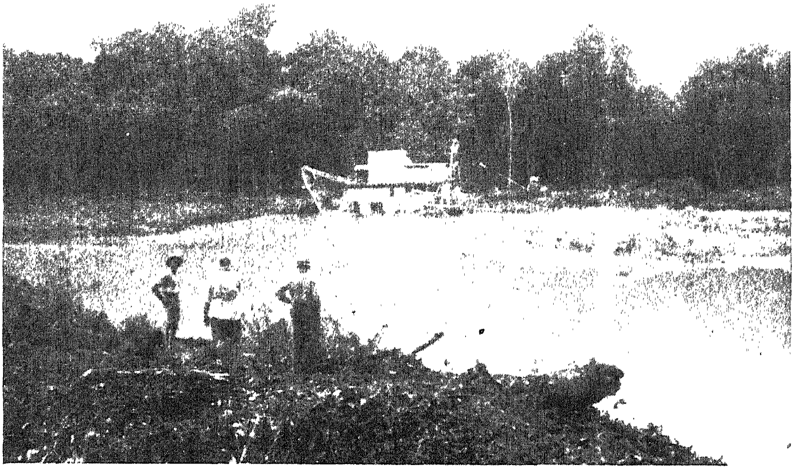


[By courtesy of Aluminium Union Ltd.

BAUXITE MINING IN BRITISH GUIANA.

[facing page 60

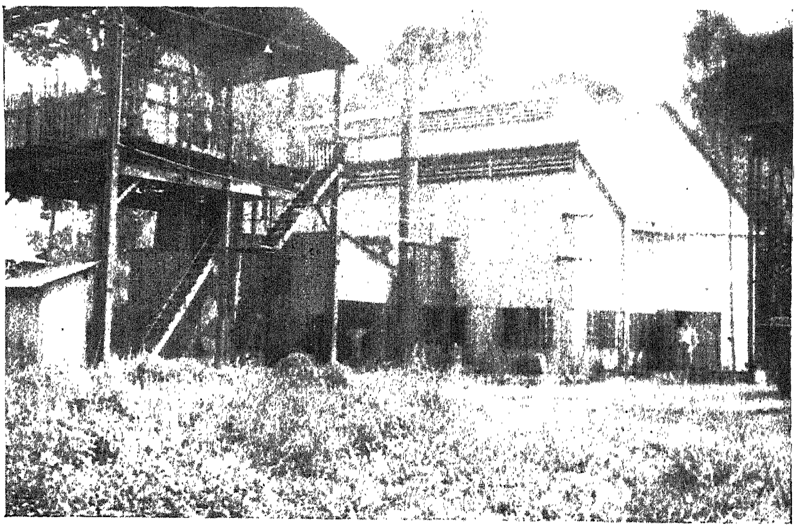
PLATE VII.



GOLD MINING IN BRITISH GUIANA. [Photo: S. Bracewell

Gold Dredge of the British Guiana Consolidated Gold Fields Co., Ltd., operating in the Mahdia River.

PLATE VIII.



GOLD MINING IN BRITISH GUIANA. [Photo: S. Bracewell

Producer-gas plant and power-plant of the British Guiana Consolidated Gold Fields Co., Ltd., Mahdia River.

acing page 61]

bauxite mined in British Guiana could be beneficiated in the Colony. As is well known, there are numerous potential sources of hydro-electric power in the large falls of low head on the main rivers and in the cataracts of the Kaieteurian escarpment. No detailed survey has yet been made of these water-power resources, although a certain amount of preliminary work has been done in this direction. There can be no doubt that the establishment of a local baxite-refining industry would be of direct benefit to the Colony, whilst the development of a cheap source of power would also assist existing industries and might lead to the setting up of new ones. These possibilities are by no means lost sight of by those concerned with the future development and welfare of the Colony. The bauxite deposits are underlain by a considerable thickness of clay and are overlain by white quartz sands, and it has been suggested that these might be utilised for the manufacture of pottery, bricks, tiles and glass, and, in conjunction with the bauxite, bauxitic clays and laterite, for bauxitic cements, abrasives, and other products. These are matters requiring further investigation. There are, however, no large deposits of limestone in the Colony.

Diamonds

Diamonds were first reported to occur in British Guiana in the year 1887. In its early stages the industry was in the hands of local syndicates, but since 1912 it has been carried on mainly by individual claim-holders and small bands of tributers (known locally as "pork-knockers") using very simple equipment. By the year 1923, when there were some 6,000 men engaged in the industry, annual production had expanded to its peak of 214,474 carats valued at $4,956,410 (£1,033,014). Since then, annual production has steadily declined and in 1945 only 121,051 stones weighing 15,442 carats valued at $459,708·34 (£95,772 11*s.* 5*d.*) were recovered. Between 1901 and 1945, 2,293,765 carats of diamonds valued at $41,089,000 (£8,609,005) were produced in the Colony. The diamonds vary in size from $\frac{1}{16}$ of a carat upwards and average about seven to the carat. The largest stone yet found was a bort weighing 97 carats, and the largest stone of gem quality weighed 56¼ carats. The value of the local diamonds increased from about $5 to $10 per carat between 1908 and 1918 and to $35 by 1920; it then decreased to $8 in 1931 and since then it has increased to $30 in 1945. Until recently, when a small cutting and polishing industry was started in Georgetown, all the diamonds were exported in the raw state.

The locations of the known diamond workings are indicated on the accompanying mineral map. The most productive areas are situated near the Kaieteurian escarpment and more particularly in proximity to the gorges in the scarp which have been eroded by rivers draining large areas of Kaieteurian rocks in the Pakaraima

Mountains. The gorges have long formed the "bottle-necks" for the alluvial material derived from the mountain areas and poured out on to the plains below, and the workable diamond deposits are largely the result of the re-distribution of alluvial fans radiating from these gorges. The workings extend for some distance from the scarp, however, and it has been observed during mapping that they are mainly confined to the belts covered, or formerly covered, by deposits of the White Sand Series. These are considered to mark the courses of former rivers which flowed north-east from the Pakaraima Mountains and so distributed the diamonds derived from the coarser members of the Kaieteurian Series.

Diamonds have been worked for the past twenty years in the headwater tributaries of the Potaro River. There, also, the deposits are situated near an elevated scarp of Kaieteurian sandstone and conglomerate. Similar conditions may be anticipated throughout this elevated area, but up to the present the absence of transport facilities to this region has been an obstacle to exploration and development. During recent years diamonds have been discovered and worked in the Ireng River, and in terraces on the Brazilian side of the river.

Resuscitation of the diamond industry of the Colony will be partly dependent upon world prices and upon the discovery and opening up of new diamond fields, as well as upon improved transport facilities and working methods. Areas calling for more detailed exploration are the higher parts of the Pakaraima Mountains and their southern flanks south of a line joining the Echilebar and Siparuni rivers. The establishment of air transport services to these areas would undoubtedly facilitate exploration.

Diamond washing pans and other equipment have been used at a number of localities. The pans appear to be capable of handling gravels averaging about $\frac{1}{10}$ of a carat per cu. yd. under existing local conditions. Attention has recently been given to the possibility of working the larger rivers in the Mazaruni Diamond-field. Diamonds were recently recovered from samples of the gravel in the Kurupung River, and small "Clam" and "Spoon" dredges have been erected in the Kurupung and Meamu rivers respectively.

Other Minerals

Other minerals of possible economic interest are known to occur in the Colony, including columbite, ilmenorutile, merumite, spodumene, quartz crystals, rutile, ilmenite, scheelite, mica, iron ore, manganese ore, potarite, chalcopyrite, molybdenite and other sulphides, euclase, beryl, euxenite, zircon, kaolin and kyanite.

There are small occurrences of asphalt at various points along the coast but a test well put down in 1940 at Rose Hall, Berbice, revealed only a few drops of oil on reaching a depth of 6,074 ft. Natural gas (mainly methane) is occasionally encountered during the drilling of artesian wells. In a consideration of the future oil

prospects, Dr. H. G. Kugler has suggested the "possibility of finding accumulations of oil off the northern shore-line of British Guiana, possibly far out to sea but still on the shallow shelf."

Policy of the Geological Survey

The chief purpose of the Geological Survey, as I see it, is to assist in the development of the mining industry. This purpose can be fulfilled by the discovery of new gold, diamond or bauxite fields or of new minerals capable of exploitation, or by indicating the possibility of the occurrence of deposits suitable for more organised working methods. This is by no means the only function of a Geological Survey; others are to advise Government upon matters pertaining to the administration of the mining industry or upon public works and development projects; but the chief task of the Survey in an undeveloped country like British Guiana is mineral exploration. There is need for further systematic geological reconnaissance of certain areas, but it is desirable that this should be accompanied by organised prospecting. It is necessary to emphasise, however, that the object should be the discovery of deposits which are likely to be of economic interest within a reasonable period having regard to the present stage, and future possibilities, of development in the Colony. For instance, the discovery of deposits of bauxite, iron or manganese ores in the more remote parts of the Colony is unlikely to be of much economic benefit at present. In present circumstances the main interest attaches to the more accessible areas, and it is for this reason that the work of the Survey during the past twenty years has been almost entirely confined to the northern parts of the Colony. Attention has been given more particularly to the possibilities of improved methods of working the gold and diamond deposits and to the discovery of such minerals as might be workable under existing, or improved, transport conditions within this area.

Mention should be made here of the "Comprehensive Economic Surveys" which are frequently advocated. It appears to be assumed by some of the advocates of such surveys that it is possible and desirable for a Geological Survey to carry out a complete and comprehensive evaluation of the mineral resources of the Colony, by some systematic grid survey. This, in my view, is quite impracticable, and it would be futile to attempt it. Mineral exploration cannot be simplified in this way, and development is more likely to be achieved by more detailed investigation of known mineralised areas. Our task in British Guiana is to maintain an appropriate balance between geological reconnaissance and laboratory work on the one hand and investigations with a more definite economic objective on the other hand, using the available staff and facilities at our disposal to the best advantage. There is need for geological reconnaissance and organised prospecting of certain areas, of systematic survey and the production of reliable

maps on a standard scale. But the most pressing need is for detailed examination of known mineralised areas in which mining operations are being conducted or which have already been indicated as the result of preliminary surveys.

It may be desirable to drill parts of these mineralised zones with the object of obtaining more reliable geological information than that obtainable on the surface. Indeed, the future of the diamond industry may be dependent upon organised exploitation of the deeper alluvial deposits and terraces, involving a fuller knowledge of the distribution and mineral content of these deposits. If investigations with this in view are not undertaken by mining concerns, then, in the general interest of the Colony, they should be carried out by Government organisations. It is doubtful whether even the question of bauxite reserves can be left entirely in the hands of the private companies. It is one of vital importance to the Colony. There is a need of collation and co-ordination of available information and investigation of the mode of origin of the deposits and their relationship to the deposits of ferruginous laterite. In the coastal area there is need for further geophysical survey with a view to determining the structure and nature of the deeper members of the Coastal Sedimentary Series in relation to the problem of oil exploration. Finally, there is clearly scope in the Colony for considerable expansion of geological investigations of all kinds with a view to the ultimate development and welfare of its inhabitants.

Acknowledgements

In preparing this review I have found it necessary to make frequent reference to the published reports of Barrington Brown and Harrison, and to the contributions of my former colleagues on the Geological Survey and of Dr. Kugler and Mr. Noël-Paton which have appeared in the twenty Bulletins of the Geological Survey of British Guiana. I am especially indebted to my former colleague, Dr. Bryn Davies, for help in the preparation of the section dealing with bauxite and to my predecessor, Dr. D. R. Grantham, for the use of many of the lantern slides which were displayed, and which had previously been presented by him to the Imperial Institute.

In conclusion, I desire to express my thanks to the Director and staff of the Imperial Institute for providing this opportunity, as well as the necessary facilities and assistance, to present a general review of the geology and mineral resources of British Guiana. Also, may I take this opportunity to record my personal appreciation of the work of the Institute in relation to our work in British Guiana. Not the least of the services rendered by the Mineral Resources Department is its maintenance of contact with Colonial Geological Surveys. These contacts are highly appreciated, as they do much to dispel that feeling of isolation to which technical officers

who are compelled to spend long periods in the Colonies are apt to fall victim. The Institute has an important function to fulfil in this respect, and we in the Colonies appreciate the services rendered and wish the Institute continued success and expansion in all its activities.

DISCUSSION

The Chairman, **Sir Frank Stockdale,** G.C.M.G., C.B.E., Adviser on Development Planning to the Colonial Office, in introducing the lecturer, said that it was nearly forty years since he (Sir Frank) had set foot in British Guiana, in the year following the publication of Harrison's work on *The Geology of the Goldfields of British Guiana.* All those who were familiar with that book may not have realised that it contained at that stage, forty years ago, a collection of the finest illustrations of the interior of the South American continent.

Mr. Bracewell had been in the Colony for a period of over sixteen years, and, during his work there, he had corrected some of the misconceptions of Harrison who preceded him, and had confirmed and added to much of the wisdom of that grand old man of British Guiana as set out in that book on the geology of the goldfields.

In the old days travelling in the interior was no easy matter. It was interesting, leisurely, and at some times hard. To-day, travelling was less difficult because one had the advantages of an internal air service which would land on any cup of water anywhere in British Guiana—and that was literally true. Mr. Bracewell had travelled throughout the interior of the Colony, a vast country little developed.

Many had given their attention to the possibilities of developing the interior of British Guiana where, except for the area of the Kanuku Mountains, there was a vast stretch of sandy soil well suited to agricultural operations. Development would depend upon the utilisation of its forest wealth, its mineral resources, and its great resources of water power which would be very valuable when industrialisation became possible.

Following a brief introduction to the Colony and its problems—problems of the interior—the Chairman called on Mr. Bracewell to deliver his lecture, after which discussion was invited.

Mr. R. F. Noël-Paton, in opening the discussion, congratulated Mr. Bracewell on the very interesting lecture he had given and, speaking as one who had spent some years before the war conducting geological inquiries in British Guiana, acknowledged the regular assistance he had received from the Geological Survey of that Colony. The Survey had resisted the temptation to indulge in geological mapping regardless of economic significance, and had confined its investigations to special areas which would seem to repay more detailed examination by commercial interests, thereby attracting these interests to the Colony and developing its resources.

The opening up of a bauxite mine or a gold mine naturally

brought in its train a great many benefits to the Colony. Capital was attracted, communications greatly improved, roads, railways, and to a limited extent, air strips were established, employment given to labour, and the spending power of the population increased. The activities of a Geological Survey were, of course, limited by the amount of money that could be spent, but the value of the work done would be increased if it were possible for the Survey to prepare, print and publish geological maps and records in sufficient quantity to let those concerned know what work was being done. His plea was one for publicity, which he considered important because it drew the attention of commercial interests to the work being done in a Colony like British Guiana, and to the possibilities of such a country.

With regard to the origin of bauxite, he thought that, whilst the lecturer had pointed out that the general theory accepted is that of the residual origin, the possibilities of precipitation from colloidal solution by electrolytes was a theory which did merit a certain amount of consideration.

Major C. Barrington Brown said that he had listened to Mr. Bracewell's lecture with the greatest interest, and particularly because of his father's close and very early connection with the Colony as, he thought, the first professional geological explorer. Possibly the audience might like to hear something of Charles Barrington Brown.

His father, Richard Brown, also a geologist, read several papers to the Geological Society of London over a century ago. Charles Barrington Brown was born at Cape Breton, Nova Scotia, 107 years ago, and had two brothers: Henry York Lyell Brown, Government Geologist of South Australia for over thirty years, and David Brown, State Mineralogist of Victoria. Barrington Brown was educated at Harvard University and at the Royal School of Mines in London, talking his A.R.S.M. in geology. His career began in Jamaica, where he was on the Geological Survey for three years. In 1867 the Colonial Office appointed Sawkins and Brown to make a geological survey of British Guiana. After three years Sawkins retired and Barrington Brown continued alone.

During the six years of exploration he travelled upon nearly every river of consequence, known and unknown, and made a geological reconnaissance of practically the whole Colony; his journeys totalled 2,130 miles on foot and over 8,000 miles on the rivers. It is now 76 years ago since that evening when, travelling down the Potaro River, he camped for the night and heard the sound of a great Fall. He and his eight men had come over the Ireng watershed and were descending the Potaro as the shortest way back to the Essequibo River. They had been living on cassava root for many days since there was no game to shoot or any other source of food. If they had returned by the Ireng River they would have perished from starvation; their only course was

to go down the Potaro. At dawn on 24th April, 1870, Barrington Brown found himself on the very lip of the Kaieteur Fall. Before descending he made a pencil sketch, showing the Fall on the right and a view of the river winding through the gorge to the Essequibo. The speaker had found this sketch in a portfolio not so long ago, and now it is in the collection of the Royal Geographical Society.

After leaving British Guiana, Charles Barrington Brown spent three years exploring the Amazon's tributaries, but returned to the Guianas on three occasions to examine gold deposits. In 1887 he made a journey to the Mogok ruby mines of Burma for the Secretary of State for India. It was a perilous journey in those days and he was the first European to see the mines. In later years he was in North Carolina, New South Wales and Ceylon. He contributed papers to the Geological, Royal Geographical and Royal Societies; and besides the Government reports on the geology of British Guiana and of Jamaica, wrote two books describing his travels in the former country and on the Amazon. An old Dutch cannon, which he found on the Rupununi, is in the Whitehall Museum, and his botanical collections are at Kew.

Mr. S. R. R. Allsop and Mr. A. A. Charles, British Council Students from British Guiana, asked whether the minor occurrences of minerals which the lecturer had mentioned were too small to be worth exploring. In particular, they asked for information concerning the discovery of uranium ore.

Mr. Gee, who was particularly interested in stratigraphy, inquired regarding the geological age of certain formations, and asked if any fossils had been found in the bauxite.

Mr. S. Bracewell, in reply, paid tribute to the work of Charles Barrington Brown, which he thought would form the basis of much of their geological investigations in the future as in the past. In 1873, Barrington Brown had recorded the occurrence of a pisolitic rock near the Demerara River, this no doubt being bauxite. Some original sketches made by him, as well as the first photographs ever taken of the Kaieteur Fall, had been presented to the Geological Survey of British Guiana by Mrs. Barrington Brown, and these were exhibited at the close of the lecture.

Dealing with the smaller and lesser known mineral deposits of the Colony, the lecturer hoped that some time in the future, when transport communications were improved, some of these might be exploited with advantage. There were perhaps a few million pounds of columbite in the Mazaruni district, but as it was worth only about 20 cents a pound, there seemed little likelihood of this mineral being worked economically at present.

Euxenite was the only uranium mineral known to exist in British Guiana, containing as it did some 8 to 11 per cent. of uranium oxide. Small pieces, a few ounces in all, of the mineral had been found in the Kanuku Mountains but the mineral, whilst radioactive, was not usually regarded as an ore of uranium. Other occurrences

were known in this region which were larger and which contained a higher percentage of uranium oxide, and the lecturer was of the opinion, that, whilst he could not see any immediate possibility of working the material, explorations should be continued in the Kanuku Mountains for uranium as well as for other minerals. In particular, there was need of a geological exploration of this region of which little was known.

With regard to the age of the various formations, the lecturer had dealt with this in his paper. No fossils had been found in the bauxite and none, except leaf impressions, in the White Sand Series, which were regarded as sedimentary. Leaf impressions occurred in some of the limonitic and haematite shales in the White Sand Series, and could be seen in the specimens exhibited. If the clays could be changed to limonite or to haematite, the lecturer could not see why similar clays should not alter to bauxite, in which case they might eventually find some leaf impressions in the bauxite.

The Chairman, **Sir Frank Stockdale,** in terminating the proceedings, referred to the first sample of bauxite which Professor Harrison had analysed, and revealed as the lecturer had intimated, that he (Sir Frank) was with Harrison and Robert Ward at Christianburg when the original discovery was made in 1910. They had been examining some rubber plantations there, and Sir Frank saw something which was a little out of the ordinary; they got some men to take out the material from various layers, and Harrison analysed it, thus providing the analyses of high-grade bauxite which were recorded in 1910 from British Guiana.

Sir Frank entirely agreed with Mr. Noël-Paton regarding the need for publicity. The Geological Survey of British Guiana had issued a number of Bulletins, but he felt that insufficient publicity was nevertheless given to those who worked so hard in building up our knowledge of the geology of that part of the Colonial Empire in which they were working. There was doubtless a mass of geological information in the hands of the geologists of oil companies, much of which, he thought, though perhaps wrongly, could be given to the world without detriment to their particular enterprises.

With regard to geology generally in the Colonies, Sir Frank referred to the new centralised Geological Survey intended to cover the whole of the Colonial Empire. He hoped that when this body got going, British Guiana would be one of the fields to receive early attention.

Mr. Bracewell, continued the Chairman, had been very modest in respect of the contributions which he had made to our knowledge, and he had not referred to the years of solid endeavour behind his work in British Guiana. The Chairman, however, could assure Mr. Bracewell that he and his work were highly appreciated by all those in the Colony concerned, and who were associated with

the exploitation of its mineral wealth. He then called for a very hearty vote of thanks to the lecturer, which was duly accorded with acclamation.

Sir Harry Lindsay, K.C.I.E., C.B.E., Director of the Imperial Institute, in thanking the Chairman for presiding over the meeting, said that Sir Frank Stockdale was an old and valued friend of the Institute, and referred to the valuable work that he had done for the social welfare and economic development of the Colonial Empire.

At the close of the meeting, a comprehensive collection of publications, maps and minerals of British Guiana was displayed for inspection.

ABSTRACTS AND NOTES

Diamond Industry Revival in South Africa.—In former years, notably just before and after the 1914-18 war, and again in the late 1920's, South Africa was by far the world's most important producer of diamonds. Economic conditions, however, led both to the closing of the pipe mines and to a recession in production from alluvial sources in the early 1930's. By 1941 and 1942 production from pipe mines had diminished to negligible proportions, although output from alluvial sources was still continued.

Since the early years of the recent war a notable revival in production from both pipe mines and alluvial deposits has taken place in South Africa, and this is well brought out by the statistical survey of the mineral industries of the Union for the years 1941, 1942, 1943, and 1944, recently released by the Government Mining Engineer. The significant figures from this report, as far as diamonds are concerned, are summarised in the following table:

Union of South Africa—Production of Diamonds

	1941	1942	1943	1944
Total Production				
Carats . .	158,422	118,821	302,329	933,682
Value £ . .	*946,095*	*701,964*	*1,812,175*	*5,846,179*
Mine Production				
Carats . .	1,304	858	84,342	552,974
Value £ . .	*3,089*	*1,082*	*480,647*	*3,095,479*
Per carat . .	45s. 9d.	25s. 3d.	114s.	111s. 11d.
Alluvial Production				
Carats . .	157,118	117,963	217,987	380,708
Value £ . .	*943,006*	*700,882*	*1,331,528*	*2,750,700*
Per carat . .	120s.	118s. 10d.	122s. 2d.	144s. 6d.

Total value of South African diamond production to the end of 1944 was £341,302,941.

For comparison, the total value of South African gold production to the end of 1944 was £2,324,989,444.

The expansion of the diamond-producing industry is attributed directly to the re-opening of some of the pipe mines, especially Bultfontein and Dutoitspan, and to the greater activity at the diggings, including renewed operation at Kleinzee. With the de-watering of the Premier mine and the re-opening of some of the other pipe and alluvial deposits, a further expansion in South African diamond output, both in quantity and value, may be expected.

Already the value of the Union's output (over £5 million) is greater than that of any other diamond-producing country in the world, though still far below her own record production of over £16½ million in 1928.

E. R. V.

Rural Water Supplies in Africa.—It is now generally conceded that, among schemes for the amelioration of the lot of native peoples, improvement of water supplies is one of the first essentials. Indeed, in the allocation of funds of native treasuries and in the granting of aid from the Colonial Development and Welfare Fund, the provision of wells and bore-holes is sometimes given priority even over health and education.

The attention of those interested in this subject is drawn to an important lecture under the above title delivered by Dr. F. Dixey and published in *The South African Geographical Journal*, 1946, **28**, April (29 pages). Dr. Dixey, the recently appointed Director of Colonial Geological Surveys, has had a very wide experience of rural water supplies in British Africa, and this paper abounds not only in the results of his own work, which was greatly extended during the war years, but also in the collation of that of others. Considerations of space preclude any attempt here at an abstract, but it is of interest to note that he casts considerable doubt on the widely held belief that Africa is "drying up." He draws attention to the many man-made causes of failure of water supplies, the climatic cycles ranging from a few years to thousands of years duration, and other factors, and concludes that no simple answer can be given to the question as to whether Africa is drying up.

A. W. G.

Coal Resources of New Zealand.—The New Zealand *Mines Statement* for 1945 contains an appraisal of the coal reserves of the Dominion, the result of an investigation by the Coal Survey and Mines Department which has been proceeding for some years. Reserves of the different classes of coal are given as follows:

Class of Coal.	Proved Recoverable.	Probably Recoverable.	Inferred.
	Tons	*Tons*	*Tons*
Anthracite	Very little	Very little	—
Bituminous (coking)	14,160,000	56,190,000	—
Sub-bituminous (non-coking)	139,094,000	103,992,000	321,000,000
Lignite (non-coking low-grade)	147,000,000	377,000,000	—
Total	300,254,000	537,182,000	321,000,000

Of the proved recoverable reserves of bituminous coal, 8,060,000 tons are situated in the Greymouth Coalfield, 5,100,000 tons in the Buller Coalfield, and 1,000,000 tons in the unworked coalfield at Garvey's Creek, in the Reefton district. For probably recoverable reserves the respective figures are 24,000,000 tons, 30,190,000 tons and 2,000,000 tons.

The major reserves of sub-bituminous coal occur in the Waikato and North Taranaki Coalfields, the Reefton district, and Southland (Ohai, etc.). Sub-bituminous coal is also worked in the Hikurangi and Kamo Coalfields of North Auckland, the Puponga and Westhaven areas in the Nelson district, and the Kaitangata Coalfield of Otago.

Southland (Mataura, etc.) contains the chief lignite reserves; lignite is also mined in the Charleston area, Canterbury and Otago.

The outputs for 1945 of the various coalfields and of the different classes of coal are shown in the following tables:

Name of Coalfield.	Output. *Tons*
Waikato (including Taranaki)	957,419
Buller	540,782
Greymouth	497,982
Southland	380,104
Otago	200,330
Reefton	122,622
North Auckland	89,525
Canterbury	37,007
Nelson	7,805
Total	2,833,576

Class of Coal.	Output. *Tons*
Anthracite	2,531
Bituminous	962,215
Sub-bituminous	1,623,336
Lignite	245,494
Total	2,833,576

(The total includes 452,680 tons obtained by open-cast mining)

Despite this high production, a record for the Dominion, the supply of coal was unequal to the demand.

P. L. R.

Rich Deposit of Bitumen in Alberta.—According to a paper read by G. S. Hume at a January, 1947, meeting of the Canadian Institute of Mining and Metallurgy, drilling operations initiated in 1942 by the Dominion Government have discovered a rich deposit

containing liquid bitumen within the bituminous sands of North-West Alberta. This deposit is located on the west side of Athabaska River, 20 miles north of Fort McMurray.

The bituminous sands vary considerably in thickness up to a maximum of 220 ft., and are interdigitated with clay and shale bands. The sands contain from 12 to 18 per cent. by weight of bitumen, as against a maximum of about 18 to 19 per cent. for fully impregnated sands. Beds of liquid bitumen (sp. gr. 1·00), varying in thickness from a few inches to 21 ft., occur interstratified with the sands. The aggregate thickness of bitumen varies from 6 in. to 57 ft.

The deposit is tentatively considered to contain 400 to 500 million barrels of bitumen. It is under light overburden, and there is an excellent tailings disposal and plant site near Athabaska River. The intention is to return the deposit to the Abasand Company for development.

P. L. R.

The Migori Gold Belt, South Kavirondo, Kenya.—An important contribution to the geology of the goldfields of the Lake Victoria region was published recently by the Geological Survey of Kenya in Report No. 10, *The Geology of the Migori Gold Belt and Adjoining Areas* by Dr. R. M. Shackleton. This comprehensive report is accompanied by a fine series of colour-printed geological maps, two sheets on the scale of 1 : 125,000 covering the whole area of the report, and eight more detailed sheets on the scale of 1 : 25,000 covering the entire length of the gold belt. The latter lies mainly in the valley of the Migori River and extends from near Karungu Bay on Lake Victoria east-south-eastwards to Lolgorien, being some 50 miles in length, 3 miles wide, and remarkably straight. A road runs along the belt to the pier in Mohoru Bay, and is crossed by the Kisumu-Mwanza road. Mining commenced in 1922 (this being the oldest producing goldfield in Kenya), but output has not been great, and although it was growing rapidly before the war and exceeded 10,000 oz. in 1939, it suffered a severe set-back during the war years. At present most interest probably centres round the large deposits of massive sulphide ores carrying promising gold and copper values at the Macalder Mine.

Here there is only space to present a summary of Dr. Shackleton's account of the mineralisation and economic geology of this gold belt. The mineralisation occurs near the contact of a narrow belt of Nyanzian rocks with a large mass of Older Granite (G_2) which extends far to the south across the Tanganyika border. This contact follows a nearly straight course for 50 miles, almost parallel to the strike of the Nyanzian rocks. Both formations are intensely sheared for up to a mile or so on either side of the contact, which dips steeply to the south, so that the granite overhangs the Nyanzian rocks which are thermally metamorphosed for distances of 200 to

900 yards. While most of the gold deposits occur in the Nyanzian rocks, one mine has been opened up just within the granite, and the mineralisation also extends locally into the Kavirondian rocks which succeed the Nyanzian to the north. The Nyanzian rocks are basic pillow lavas, andesites, tuffs, conglomerates, greywackes, shales and banded ironstones, and associated with them are intrusive dolerites, porphyrites and porphyries which were probably more or less contemporaneous with them. Mineralisation is best developed in the shales and banded ironstones, though not restricted to these types.

It is inferred that the mineralisation accompanied the intrusion of the Older Granite which occurred during the post-Nyanzian orogeny and continued during Kavirondian times. As the granite was squeezed upwards the overlying rock mass must have given way along a fault plane, the rocks to the south being lifted up as a roof on the rising magma, while those to the north formed the wall of the intrusion. The Younger Granites (G3), of post-Kavirondian age, which also occur within and around the gold belt, do not appear to have caused any mineralisation.

Three types of gold deposits are recognised in this belt; the most common are auriferous quartz veins carrying pyrite, arsenopyrite, chalcopyrite, carbonates, chlorite and tourmaline, etc.; in a few occurrences quartz is virtually absent and the gold is associated with pyritic impregnations in sheared dolerite; and thirdly there is an important group of massive sulphide ore-bodies at the Macalder Mine. Metasomatism of the wall rocks has resulted in the formation of sericite, chlorite and actinolite, but albitisation is not marked. Of the principal deposits described, one is worked just within the granite, 14 occur within a mile of the contact, 5 from one to two miles, and the Macalder sulphide ore bodies are 2½ miles from the contact.

The veins usually occur *en échelon* in vein systems which are aligned parallel to the strike of the country rocks, but each individual vein diverges to the left and overlaps its neighbour to the right. Most of the veins dip towards the granite, and it is suggested that a similar *en échelon* arrangement may occur in a vertical direction. The fractures in which the veins occur appear in most cases to have been produced by shear and not by tension, some being thrust planes, parallel or making a low angle with the bedding, others being faults. A few of the veins have a visible strike length of 2,000 ft., but most of them are considerably shorter, and the width is usually less than four feet. One reef is still strong at a vertical depth of 650 ft., but as few of the veins have been bottomed their vertical extent remains unknown. Gold mineralisation is severely localised, usually in shoots, but as yet there is insufficient data to allow of generalisations on their behaviour, although it is suspected that a prevalent eastward pitch may be characteristic.

The principal deposits, taken in order from west to east, are the

Macalder properties, reefs around Masara Hill, and the former Kenya Gold Mining Syndicate's mines, all within ten miles of the western end of the belt, the Allenby Reef group in the middle, the Kahancha group, and the Lolgorien mines at the eastern end of the belt. A few of the more interesting features may be noted here. Macalder Mines Ltd. have developed several quartz reefs, but their main activities now centre around the sulphide ore-bodies in the Macalder Mine, just north of Masara Hill. The ore-bodies are a branching series of lenticular veins extending over a distance exceeding 1,200 ft. in a general N.W.-S.E. direction and dipping with the surrounding rocks to the N.N.E. They are usually associated with thin sheets or lenticles of banded ironstone which occur at the contact between metabasalts and greywackes, and they are believed to have been formed by replacement along faults. The veins, which are frequently 20 ft. or more in width, consist of massive banded sulphides, oxidised to a mass of auriferous iron oxides to a depth of about 120 ft. At the base of this gossan there is a thin and impersistent zone of secondary copper enrichment. The primary ore is a fine-grained streaky granular aggregate of pyrite, pyrrhotite, chalcopyrite, magnetite, arsenopyrite, sphalerite and galena, with interstitial calcite. An analysis of a composite sample from the third level (which does not necessarily represent average ore) gave 3·5 dwt. gold, 3·1 oz. silver, 3·83 per cent. copper, 5·13 per cent. zinc, 0·89 per cent. lead, 0·26 per cent. cobalt, 32·29 per cent. iron and 25·70 per cent. sulphur. A mill with a capacity of 150 tons per day is now treating the gossan ore which is worked in large open-casts. The primary ore will require flotation and smelting.

In the Achar Reef, two miles S.E. of Masara Hill, the primary ore was a pyritic impregnation along an irregular shear in metadolerite, but only the oxidised ore was worked, being rich but patchy, with a pay strike of 300 ft. at the surface but only 100 ft. at the 100 ft. level. Blackhall's Reef, at the former Kenya Gold Mining Syndicate's Mine, was the earliest to be mined in Kenya. It occurs in sheared porphyrite 1,000 ft. from the granite contact and the ore-body, which is up to 5 ft. in width, has a length of over 1,000 ft. at the surface, though it decreases in successively lower levels to zero at about 700 ft. The payable portion of the vein formed a wedged-shaped area within which definite shoots were not well defined. The Kisumu Reef, further east, is a brecciated quartz vein in andesitic tuff, heavily mineralised with arsenopyrite and pyrite. It yielded high gold values in rather small shoots, and was one of the few mines where good gold values were obtained outside the vein in silicified rock which was hard to distinguish from country rock.

In the neighbourhood of Kahancha at least six groups of reefs have been worked in the shales and tuffs within a mile of the granite contact, and recently the Sagire vein lying just within the

contact in strongly sheared granite has been brought into production. The vein is over 1,500 ft. in length and the quartz is a platy white variety with brown films, often containing visible gold. Around Lolgorien, Kenya Consolidated Goldfields Ltd. have a number of properties, the Blue Ray, Alpha Ray and Caldwell being on reefs about 2,000 ft. in length. In the Maghor Mine the vein lies at the contact of a granite porphyry and Kavirondian boulder beds.

Residual gold deposits of the " rubble type " are well known in the gold belt and have yielded considerable quantities of gold, profitably when systematically sampled and exploited. The recent alluvium of the region has not been proved to contain workable gold deposits and is not promising. Gravels beneath the Tertiary volcanic lavas east of Lolgorien, however, may contain payable gold values and deserve careful prospecting.

T. D.

Geological Work in Tanganyika.—The following account of work carried out by the Geological Division of the Department of Lands and Mines, Tanganyika, during the year 1946, has been received from the Chief Geologist.

One geologist was available throughout the year; one for seven months, being on leave for the remainder; and one for seven months before retirement. The Chief Geologist also did some field work. One metallurgist was available for seven months and a newly-appointed one for two months. Two Italian Cooperators, one a metallurgist and one acting as Storekeeper and Librarian, left in August. A geological draughtsman was appointed and worked for seven months before going on leave. A temporary metallurgist was employed for two months.

Geological work has been chiefly in two areas, in the Southern Province and in the Ufipa and South Kigoma Districts. In the former, reconnaissance geological survey covered 2,300 sq. miles. Two new coalfields were discovered 40 and 50 sq. miles in area respectively, on the tributaries of the Ruvuma River, south of Songea. In each coalfield several seams of economic thickness were located and outcrop samples taken. Palæontological evidence of the age of the higher Karroo beds was found and a collection of reptilian and other bones was sent away for examination.

Deep drilling for coal in the North-Western Rukwa Valley by a contracting company continued for over a month till the rains made further operations impracticable. In 1945-46 five holes were drilled, totalling 3,247 ft., of which two penetrated coal seams of economic value. A further 850 ft. of drilling by hand tools to depths not exceeding 100 ft. was done by the Geological Division in the dry season. Two holes cut possible coal-bearing rocks, but the rest penetrated nothing but lake beds and superficial deposits.

The geological survey of the Mukwamba (Mpanda) lead-silver-copper-gold mine and its environs was continued. Certain diamondiferous areas were prospected. Analyses done by the Imperial Institute showed that rocks from a considerable area in the Njombe District carry platinum.

The laboratory work continued until August when the simultaneous departure of the three metallurgists (leave, repatriation, retirement) forced the closing of the laboratory. It re-opened in November. Some 880 analyses and assays (complete or partial) were carried out, as well as various ore-tests. Phosphatic limestone, coal, nickel ore, water, brine, cyanidation, etc., were examined in the laboratory and police work in connection with gold and diamonds was undertaken.

Maintenance of the Dodoma geological museum is an important phase of the work. It was visited by about a thousand people during the year. A few lectures were given to school parties.

A Short Paper summarising the results of the work of the past three years on the Namwele-Mkomolo Coalfield was prepared and published. A Short Paper on the geology and mineral deposits of the Njombe District and a pamphlet on nickel occurrence were prepared. An article on a phosphatic limestone for use as a fertiliser was written and published.

The Dodoma geological buildings were enlarged by a new assay furnace room. The erection of the continuous mineral dressing plant was completed and the plant ran for a few weeks. A workshop was constructed and equipped.

The Mineral Production of Sierra Leone.—The following statistics of the mineral production of Sierra Leone for the years 1939 to 1944 have been furnished by the Chief Inspector of Mines.

	Unit	1939.	1940.	1941.	1942.	1943.	1944.
Diamonds .	*carat*	683,709	885,414	849,912	1,046,187	834,492	608,734
	£	*811,907*	*780,770*	*749,463*	*922,754*	*938,803*	*723,176*
Iron ore	*ton*	828,560	689,290	1,029,970	623,270	556,515	454,660
(exports)	£	*650,325*	*515,090*	*801,511*	*476,339*	*430,641*	*384,567*
Gold, crude	*oz. troy*	36,938	35,375	25,613	12,449	3,072	1,117
and unrefined	£	*260,188*	*274,478*	*198,231*	*96,132*	*23,375*	*8,618*
Chrome ore .	*ton*	10,585	17,496	13,687	10,557	16,048	9,695
	£	*21,629*	*50,290*	*49,169*	*38,972*	*60,180*	*36,259*
Platinum,	*oz. troy*	83	135	5	—	—	—
coarse, crude	£	*527*	*981*	*28*	—	—	—

W. B.

The Mineral Production of Northern Rhodesia.—The statistics of the mineral and metal production given in the table on p. 77 have been furnished by the Chief Inspector of Mines, Ndola, Northern Rhodesia.

W. B.

NORTHERN RHODESIA—MINERAL AND METAL PRODUCTION, 1939-1945

	Unit.	1939.	1940.	1941.	1942.	1943.	1944.	1945.
Gold (Fine)	*oz.*	4,645	5,782	3,401	1,134	703	307	265
Silver (Fine)	,,	80,137	311	45,699	104	41	—	2,269
Cobalt alloy	*cwt.*	(*a*) 76,601	(*b*) 37,800	(*c*) 37,228	(*d*) 44,157	(*e*) 47,615	(*f*) 46,582	(*g*) 33,430
Copper (Blister)	*ton*	182,014	235,559	204,031	201,510	189,760	159,127	132,690
Copper (Electrolytic)	,,	29,654	26,835	24,223	45,087	61,195	61,700	61,324
Copper (Other)	,,	—	—	—	9	43	26	63
Iron ore	,,	136	267	267	388	614	209	75
Lead	,,	160	288	372	1,100	1,245	1,030	1,720
Manganese ore	,,	2,970	3,494	4,700	6,113	4,711	5,046	1,934
Selenium	*lb.*	1,277	—	—	—	—	—	—
Tin concentrates	*ton*	—	23	15	5	5	8	25
Zinc	,,	12,695	13,190	13,545	12,840	13,405	14,480	15,240
Vanadium pentoxide	,,	674	647	600	682	749	447	385
China-clay	,,	—	—	—	—	4	1	—
Limestone	,,	46,133	73,014	89,118	80,579	80,178	79,083	73,330
Mica (Sheet)	*lb.*	4,547	1,947	1,345	6,015	18,835	32,484	11,778
Mica (Waste)	,,	—	—	211	2,171	4,348	2,965	3,969
Silica rock	*ton*	3,430	—	1,408	485	228	—	1,553

(*a*) 40·65 *per cent.* Co.
(*b*) 40·88 ,, ,,
(*c*) 40·03 ,, ,,
(*d*) 40·37 ,, ,,
(*e*) 40·34 *per cent.* Co.
(*f*) 40·34 ,, ,,
(*g*) 39·89 ,, ,,

Geological Survey of Nigeria.—The following short report on the work carried out by the Geological Survey Department during the year 1946 has been received from the Acting Director.

During 1946 the activities of the Department showed considerable increase, though staff was still well below half the approved establishment. A branch office was opened at Jos having as its main aim the assistance of development of mineral resources in the tinfields. Dr. F. Dixey, O.B.E., Director of Geological Survey, left Nigeria on the 1st December, 1946, to take up his new duties as Director of Colonial Geological Surveys, with headquarters in London.

In general, geological investigations were concentrated in mineralised areas, but in each area outstanding scientific problems were given due consideration. The following investigations were of particular interest and accounts will be included in the Annual Report of the Geological Survey Department, 1946.

i. The geology of the Plateau Tinfields was further remapped by Dr. R. A. Mackay, Mining Geologist, and Mr. J. E. Rockingham.
ii. The geology of the Egbe District of Kabba Province continued to receive study by Mr. E. H. Jaques, Geologist.
iii. Mapping of the geology of the Oshogbo and Ife Districts of Oyo Province (Ilesha Goldfield) was commenced by Mr. A. M. J. de Swardt, Geologist.
iv. Field work was carried out by Dr. J. W. du Preez, Geologist, on the Upper Coal-Measures in the Onitsha Province.
v. A study was made of the structures of the lead-zinc deposits at Zurak, Plateau Province, and Ameka in Onitsha Province by Dr. R. A. Mackay.
vi. A brief investigation of the cause of subsidence of buildings in Sokoto town was undertaken by Dr. F. Dixey.
vii. The geomorphic history of the Kaduna Valley received the attention of Mr. A. M. J. de Swardt, Geologist.

In addition very detailed work was carried out in the Liruei'n Kano tin-wolfram-columbite area by Mr. R. R. E. Jacobson, who is now engaged in research on the rocks and minerals of the area at the Imperial College of Science and Technology in London.

The newly-appointed Mineralogist, Dr. B. C. King, arrived in Nigeria on the 17th July, 1946. Apart from two short visits made to the Jos area during the year he spent the remainder of the year at Headquarters, and among his other activities completed the installation of the new quartz spectrograph, the operation of which will open up many new lines of investigation and research. The Laboratory continued to undertake analyses and identifications for other Departments and the general public.

Increased staff led to the resumption of regular investigations of the geological aspects of water supply. The number of wells

sunk for the rural population during the year rose to a record figure of 241 and drilling operations were continued. An attempt to investigate further the artesian potentialities of the Chad Basin had to be discontinued owing to the limit of the present drill having been reached. A comprehensive programme for water drilling schemes has been drawn up, and as soon as staff and equipment arrive, this aspect of water supply will be considerably expanded.

The United Kingdom Atomic Energy Bill.—This bill gives the Minister of Supply extremely wide powers. After defining the general functions of the Minister as regards the promotion and control of the development of atomic energy, it details his powers to obtain information and to inspect, which may relate, *inter alia*, to any prescribed substance in a person's possession or under his control, and to any minerals in his possession or under his control or present in or on land owned or occupied by him. The Minister is empowered to do on, over or below the surface of any land such work as may be considered necessary for the purpose of discovering whether there is present in or on the land, either in a natural state or in a deposit of waste material obtained from any underground or surface working, any minerals from which in his opinion any of the prescribed substances can be obtained. The Minister is empowered to acquire compulsorily the rights to work any prescribed minerals in or on any land and numerous other rights may be compulsorily vested in him to this end.

The Minister may prohibit, except under the authority of a licence granted by him, the working of any specified minerals or their acquisition, production, treatment, possession, use, disposal, export or import.

Other sections of the bill deal with the control of production and use of atomic energy and the publication of information. Attached schedules deal with compensation for work done in searching for minerals, the procedure for compulsory acquisition of certain property and the compensation therefor.

In a number of cases the Minister can exercise his powers by means of an order or written notice, but in the case of the compulsory acquisition of the rights to work minerals any order made will be subject to special parliamentary procedure. The Minister has not as yet issued any order specifying any minerals the mining of or trading in which is restricted under these new powers. It has to be remembered, however, that the export of uranium-bearing minerals in the United Kingdom and most Empire countries is prohibited under wartime regulations which are still in force, but as these expire new ones are being introduced.

A. W. G.

Colonial Mining Law.—The following among recent changes in Colonial mining law are selected as being of special interest.

Sierra Leone. No. 34 of 1946, entitled "An Ordinance to Amend the Minerals Ordinance, 1927," provides a simple method whereby natives of the Protectorate may mine for alluvial gold on their own account in certain areas, to be specified by *Gazette* notice, without having to obtain a mining lease or mining right. Control of these itinerant mining activities and disposal of gold won is secured through licences and wardens who will work in conjunction with the tribal authorities and the Mines Department. The holder has personally to work the area but may employ not more than three assistants.

A point of interest is that each licence will expire on 31st December in the year in which it is issued, so that, in the event of a find of gold of a nature which natives of the Protectorate cannot work to suitable economic advantage, the interests of the country in having the area developed to extract the maximum quantity of gold without waste can be secured by the grant of an ordinary mining title to a person capable of providing the necessary capital and skill.

Tanganyika. "An Ordinance to amend the Diamond Industry Protection Ordinance" was published as a special supplement to the *Tanganyika Territory Gazette*, dated 20th December, 1946.

The main purpose of this amending ordinance is to strengthen the existing powers for the prevention, detection, and punishment of theft of industrial diamonds which is becoming an increasing mischief in Tanganyika. The principal new provisions are the following:

(*a*) Conferring upon the Director of Lands and Mines full power to approve or veto the persons who are authorised to engage in the mining industry.

(*b*) Enabling full control to be exercised over the methods of cutting diamonds and the use of diamonds in the manufacture of machine tools.

(*c*) Enabling closer control to be exercised over the exportation of diamonds and the importation of uncut diamonds.

(*d*) Enabling a sentence of imprisonment to be imposed for a first offence and the confiscation of diamonds in respect of which an offence is committed, even though they may be owned by the offender.

(*e*) Conferring power of entering, search and arrest upon the Director of Lands and Mines and persons to whom he has delegated such powers.

(*f*) Enabling honest finders of unclaimed diamonds to be rewarded.

(*g*) Restricting the right to trade in diamond areas.

(*h*) Protecting from criminal penalties and civil damages officers who act reasonably in the exercise of their powers under the Ordinance.

A. W. G.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

RARER METALS. By Jack De Ment and H. C. Dake. Pp. xiv + 392, 9 × 6¾. (New York: Chemical Publishing Company, Inc., 1946.) Price $7·50.

The object of this book, according to its preface, is to present a compilation of basic data on rarer metals for the use of the busy professional or student. Twenty-three of the less familiar elements are dealt with, special consideration being given to those upon which it is considered that much of our future progress may depend. The metals of the rare earths are not included, as an extensive literature with regard to them already exists.

The information given is of a most diverse character. Thus the opening chapter on beryllium contains sections on the history of the element; its distribution in minerals; some account of the world occurrences and the market for beryl; the physical and chemical properties of the metal; its principal compounds; the extraction of the metal from beryl; the technology and uses of the metal and its alloys, the oxide, and the silicates; and a section on analysis which is divided into the ore assay, microchemical tests, and fluorochemical tests. Such a scheme appears admirable and is applied to all the metals dealt with.

On a careful reading, however, the book does not sustain the high promise that a cursory examination suggests. Numerous tables are given listing the many minerals containing a particular element, the theoretical content of that element being given in each case. These are of little practical use to anyone and least of all to the busy professional as it so often happens that the minerals with the highest content of the element concerned are unobtainable commercially. More serious, however, are the indications of lack of balance and insufficient care in compilation. In general the sections on chemistry, physical properties, and technical applications are better done than are those on the mineralogical aspects and mineral industry, which are disappointing. Two examples from the first few pages will suffice. On p. 2 we are told, without amplification, that "beryllium is sometimes found in small amounts together with monazite and other rare earth sands, and in aluminous schists," and on p. 23 we are told of the presence of gallium in the sun, in meteorites, and in distant stars, whereas the more practical aspect of its occurrence in the ash and flue dusts of certain Northumbrian and Australian coals is omitted. Likewise McLellan's view (*American Mineralogist*, 1945, **30**, 635-638) that, contrary to general belief, indium is contained in lead rather than zinc minerals is surely more important to either the busy professional or the student than to be told that indium is present in the sun.

The book is marred by many such blemishes and can only be described as good in parts.

A. W. G.

REPORTS ON FUEL ECONOMY SINCE 1939: British National Committee, pp. 52, $9\frac{1}{2} \times 6\frac{1}{4}$, price 1s. *6d.*; United States National Committee, pp. 12, $9\frac{1}{2} \times 6\frac{1}{4}$, price 6d.; Danish National Committee, pp. 6, $9\frac{1}{2} \times 6\frac{1}{4}$, price 6d.; Netherlands National Committee, pp. 5, $9\frac{1}{2} \times 6\frac{1}{4}$, price 6d.; Swedish National Committee, pp. 20, $9\frac{1}{2} \times 6\frac{1}{4}$, price 1s. (London: Central Office of the World Power Conference, 1946.)

These publications constitute preparatory material for the Fuel Economy Conference of the World Power Conference to be held at The Hague in September, 1947, and are contributed by national committees of the World Power Conference.

The first to appear, that of the United States National Committee, resembles a bibliography rather than a report. In fact, the report proper occupies only $3\frac{1}{2}$ pages, and could have been made considerably more useful, to give but two examples, by including statistics of production and demand, and by stating some details of how the technical problems relating to increased production were met.

In contrast with the above report is that of the British National Committee, where five tables of statistics and a six-page bibliography are complementary to many pages of descriptive matter, which are divided into eight sections. Section I deals with the conditions which made fuel economy necessary; it shows the decline in coal output as a result of the great loss of manpower in the industry, lists the numerous increases in the price of coal, and describes the enforced substitution of inferior fuels by different classes of consumers. Section II is an account of the elaborate administrative machinery which came into existence to control fuel supplies, to restrict the use of fuel, to organise a fuel economy campaign both in industry and in non-industrial and domestic establishments, and to organise propaganda and publicity in connection with fuel economy. The quantity of electricity generated during 1945 amounted to nearly 53 per cent. more than the 1938 figure, while the gas sold in 1945 showed an increase of more than 21 per cent. over the 1938 quantity: the technical problems resulting from these much higher demands, which are still increasing, are mentioned in Section III. The following section states that, during the war, about two-fifths of the total liquid fuel burnt in industry was replaced by creosote-pitch mixture. Methods of fuel economy in industry are analysed in Section V; consideration is given to boiler-house practice, furnace practice, generation and use of power, and transmission and utilisation of steam. Restriction in the supply of fuel-burning equipment, and the development of new appliances, are dealt with in the next section, and Section

VII summarises the educational activities pursued in relation to fuel economy. The concluding section mentions some of the results achieved in certain industries and indicates, with examples, where there is scope for improvement in the future.

The short Danish report shows how the reduction in fuel imports occasioned by the German occupation was met. The pre-war production of peat and brown coal was multiplied many times, and the use of these fuels necessitated alterations in firing methods and firing plants; some of these alterations are described. Many diesel engines were converted into gas engines, and many oil-fired furnaces changed to firing by coal dust. Essential motor traffic was fitted with gas producers using dried beech wood and well-dried high moor peat.

The report of the Netherlands National Committee states that although the pre-war coal production was little changed as a result of the events of the war, the seizure by the Germans of the enormous stocks of crude and refined petroleum caused an extreme fuel shortage and a closing-down of much industry. The administrative measures taken by the Netherlands authorities in order to ensure fuel economy were extensive, but in industries working for the enemy, efforts were directed to sabotage rather than to increasing efficiency.

The Swedish report is divided into sections dealing with hydro-electricity, coal and coke, peat, wood, liquid and gaseous fuels, fuels from waste, fuel economy, heat economy, and regulation measures. There is a comprehensive bibliography. Among the many interesting items contained in this report, are accounts of the use of surplus hydro-electric energy to produce shale oil by heating the rock *in situ*, and the use of tar from coniferous wood as motor fuel.

P. L. R.

ESSENTIALS OF PETROLEUM: A Key to Oil Economics. By P. H. Frankel, Dr. rer. pol. (Vind.), M.Inst.Pet., M.Inst.F. Pp. xv + 173, 9 × 5¾. (London: Chapman & Hall, Ltd., 1946.) Price 15*s*.

Written with a view to supplying information on the basic factors underlying the structure of the oil industry, this book presents, in an easily readable form, the salient points of an intricate subject.

A brief introductory section is followed by a consideration of the special economic problems that arise in the production, refining, transport and marketing of petroleum owing to the fact that it is a liquid fuel. The theme developed is that the financial structure of the industry, based upon high fixed and low variable costs, dictates a trend towards co-ordination of interests and the development of big working units. The third part of the book, which is really a continuation of the second, shows that price changes

amongst petroleum products have little effect, except perhaps in the long run, upon their output or upon the demand for them.

The next section is mainly historical, and describes how the contrasting conceptions of Rockefeller and Deterding each led, under the particular conditions in which they were applied, to a successful stabilisation plan for the industry.

Having discussed the economic structure and history of the industry, the author seeks, in the fifth section of his book, to derive logical policies for the future. Here he treads upon more slippery ground than hitherto, and although his professed aims are to demonstrate what can and cannot be done, and not what ought to be done, it is certain that some of his conclusions will not command general agreement.

The two appendices deal respectively with motor spirit prices and the economics of tanker shipments; there is also a bibliography and index. Many quotations appear in the text of the book, and each of the five parts is followed by extensive notes and references.

The author's frequent use of colloquial phrases and catchwords savours of the uninformed journalese which he himself deprecates, and may tend to give the general reader the erroneous impression that this work is not a serious and reasoned study in economics. However, his clarity of expression, combined with his gift for selecting and giving prominence to the most important features of a somewhat abstruse subject, have enabled the author to produce a useful work which fills a notable gap in the literature on petroleum.

P. L. R.

PETROLEUM PRODUCTION ENGINEERING: OIL FIELD DEVELOPMENT. By Lester Charles Uren. Third Edition. Pp. xiii + 764, 9 × 6. (New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1946.) Price 35*s*.

The first edition of *A Textbook of Petroleum Production Engineering* was reviewed in this BULLETIN over twenty years ago (1924, **22**, 260). For the succeeding edition of the work a two-volume plan was adopted; the first volume, on *Oil Field Development*, was published in 1934, and the companion volume, entitled *Oil Field Exploitation*, appeared in 1940.

In the work under review, which is a revision of that published in 1934, the Professor of Petroleum Engineering in the University of California presents a detailed description of petroleum production engineering operations up to and including the stage at which wells are completed. The first two chapters briefly describe the application of geology and geophysics to petroleum technology, and Chapter III outlines the important factors to be considered in oil-field development. The chapter in the preceding editions on the acquisition of title to oil lands has been deleted, as it will form part of another volume that the author is preparing.

Over one-third of the volume (Chapters IV-X) is allotted to drilling equipment and methods. The increased importance of rotary drilling is reflected in the fact that five chapters are now devoted to this subject, a total of 184 pages as against the one chapter of 57 pages in the 1924 edition.

Chapters XI to XIV deal respectively with well casing, oilfield hydrology, fishing, and well-completion. The remaining two chapters give a comprehensive account of methods of well logging, the examination of formation samples and ground waters, and well-surveying. There is a useful selected bibliography at the end of each chapter.

The book is printed on good paper, and, with the exception of Chapter II, is very well illustrated. Through the extensive revision and enlargement effected by the author in order to keep it abreast of the many advances in petroleum technology, this work preserves its value as a textbook to the student of petroleum engineering and as a reference manual to the professional engineer.

P. L. R.

STANDARD METHODS FOR TESTING PETROLEUM AND ITS PRODUCTS. Eighth Edition. Pp. xvii + 576, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: The Institute of Petroleum; Philadelphia: The American Society for Testing Materials, 1947.) Price 17*s*. 6*d*. ($4·00.)

The seventh edition of this book was reviewed in this BULLETIN, (1946, **44**, 263). The present (eighth) edition, which includes eight new methods and some amendments to previous methods, is similar in general form, although a minor improvement is the insertion of a vertical line in the margin to indicate changes which have been made in the text of the method.

The eight new methods consist of procedures for the estimation of barium, calcium, phophorus and zinc in unused lubricating oils; a corrosion test for lubricating greases; a method for the determination of the flash-point of liquid asphaltic bitumen; a test to measure the tendency of turbine oil to deteriorate under specified conditions and a modification of the Schwartz method of estimating tetra-ethyl lead in motor fuel, designed to replace the bromination method, which has not proved entirely satisfactory for certain types of fuels and which is accordingly withdrawn.

Seventeen methods have been altered to various extents. For example, various amendments have been introduced into the procedure for determining Viscosity (Kinematic) in Absolute Units, the most important being the withdrawal of the use of 60 per cent. sucrose solution as a primary standard and the employment of distilled water as a substitute. A few minor amendments have been made to the two methods for determining Knock-Rating of Aviation Fuels (Weak Mixture) and of Motor Fuels (I.P. Motor Method).

W. H. B.

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PLANT AND ANIMAL PRODUCTS

ARTICLE

JUTE AND ITS SUBSTITUTES: POSSIBILITIES OF PRODUCTION IN THE COLONIAL EMPIRE

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ABOUT 97 per cent. of the world's jute is produced in India. The annual production in countries outside India is about 40,000 tons, compared with an annual production in India which during this century has varied from 1,000,000 to 2,000,000 tons. Some idea of the extent of jute cultivation in India can be gathered from the fact that to obtain the figures of production mentioned above, acreages under jute of from 2,000,000 to 3,000,000 were required.

The following table shows the production of jute in India during recent years, together with the quantities exported and those used for internal consumption :

DISTRIBUTION OF JUTE
(000's bales of 400 lb. each.)

Season.	Calculated production.	Export.	Indian consumption.		
			Village consumption.	Probable mill purchases.	Total.
1929-30 .	11,294	4,512	339	6,443	6,782
1930-31 .	10,893	3,416	327	7,150	7,477
1931-32 .	7,108	3,113	213	3,782	3,995
1932-33 .	8,996	3,513	270	5,213	5,483
1933-34 .	9,730	4,248	292	5,190	5,482
1934-35 .	10,366	4,386	311	5,669	5,980
1935-36 .	8,627	4,136	259	4,232	4,491
1936-37 .	11,225	4,884	337	6,004	6,341
1937-38 .	11,895	3,728	357	7,810	8,167
1938-39 .	9,092	3,842	273	4,977	5,250
Average of 10 years .	9,923	3,978	298	5,647	5,945
Percentage.	100	40·1	3·0	56·9	59·9

Source: *Report on the Marketing and Transport of Jute in India* (Indian Central Jute Committee, First Report).

Although jute had been known in India for hundreds of years, its cultivation did not develop until the beginning of the nineteenth century. The fibre had been used for cordage and for making

coarse cloth, and later hand-woven goods were made and exported. The possibilities of the material had become known and about 1838 Dundee mill-owners had acquired the technique for spinning jute on their flax machinery and the exports of raw fibre from India began to increase enormously.

The importance of jute as a bagging material lies in the fact that it is both abundant and cheap. As a fibre it has no particularly outstanding qualities. In yarn strength and resistance to rot it is inferior to many other fibres, and it is very difficult to bleach. As a sacking material it has one advantage, however, in that in jute bags small holes made during transport, unloading, etc., tend to close up, and in this respect it is superior to many of the fibres which have been suggested as substitutes.

In India jute is grown as a cash crop, about one-third to one-quarter of the cultivator's land being under jute. It has been estimated that in 1937-38, for example, the average area sown with jute by each cultivator was about 1½ acres, which produced a green crop of about 29,568 lb., from which about 1,807 lb. of fibre were obtained, or about 6 per cent. of the green plants. It is not possible for each cultivator and his family to harvest this crop on their own, and although there is some co-operation among cultivators at harvesting and retting time, it is also necessary to employ labourers, who are paid by time, work done, or by a share in the amount of fibre produced. The following table shows the average number of men employed on the cutting, retting, stripping, etc., of the fibre from one acre in Bengal, and the wages and expenses incurred:

AVERAGE COST OF PREPARATION OF JUTE FIBRE FOR MARKETING
(*Per acre.*)

Items of expenditure.		Bengal								
		East.			North.			West.		
1. Cutting and bundling										
No. of hands . . .			17			15			17	
Wages . . .	*Rs.*	0	6	6	0	6	9	0	6	2
Expenses . . .	,,	6	15	5	6	13	8	6	8	10
2. Carrying and steeping										
No. of hands . . .			7			9			6	
Wages . . .	*Rs.*	0	6	9	0	7	2	0	6	3
Expenses . . .	,,	2	15	3	4	0	6	2	5	6
3. Stripping and washing										
No. of hands . . .			32			19			21	
Wages . . .	*Rs.*	0	6	7	0	7	4	0	6	10
Expenses . . .	,,	13	4	0	8	11	4	8	15	6
4. Drying and bundling										
No. of hands . . .			7			5			6	
Wages . . .	*Rs.*	0	6	8	0	6	8	0	6	3
Expenses . . .	,,	2	14	8	2	1	4	2	5	6
5. Total expenses per acre .	*Rs.*	26	1	4	21	10	10	20	3	4
Yield per acre, 1937-38 (mds.)			13·36			10·40			10·44	
6. Expenses per md. . . (of 82$\frac{2}{15}$ lb.)	*Rs.*	1	15	3	2	1	4	1	15	0

Source: *Report on the Marketing and Transport of Jute in India* (Indian Central Jute Committee, First Report).

Finlow, however, estimates that if the cultivation is done by hand labour and a pair of bullocks, the charges for labour and the hire of bullocks would be more like Rs. 75 per acre, and if the yield per acre is 15 maunds, the cost of producing a maund would be about 5 rupees. Since, however, much of the labour is done by the cultivator's family and the bullocks are his own, very little cash is paid out in cultivation, but a rough sale price of 5 rupees per maund seems to be necessary if the crop is to be economic over any length of time.

It is also interesting from a cost point of view to consider the charges which are incurred on jute after it leaves the grower and is sold in Calcutta. The following table shows charges incurred in October, 1937 per maund of $82\frac{2}{15}$ lb. :

Market.	Prices paid to cultivators.	Market allowances.	Other expenses at the baling centre.	Transport charges from the interior to Calcutta.	Overhead expenses in Calcutta.	Landed price in Calcutta (1) + (2) + (3) + (4) + (5).	Average of calculated prices in Calcutta in October 1937.
	1	2	3	4	5	6	7
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
Netrakona .	5 0 7	0 0 10	0 7 11	0 10 7	0 1 6	6 5 5	6 6 9
Charmugria .	4 15 5	0 4 0	0 7 9	0 6 9	0 1 6	6 3 5	6 0 4
Tarpassa .	5 0 0	0 2 9	0 7 9	0 7 3	0 1 6	6 3 3	6 5 11
Ashuganj .	5 2 10	0 2 0	0 7 6	0 8 3	0 1 6	6 6 1	6 4 5
Nakalia . .	4 11 9	0 2 0	0 7 6	0 7 9	0 1 6	5 14 6	6 2 0
Domar . .	5 2 8	0 4 4	0 7 7	0 13 2	0 1 6	6 13 3	6 4 5

Source : *Jute*, 1944, page 44 (Indian Central Jute Committee).

Of the total price realised in Calcutta, therefore, the grower receives about 80 per cent. while handling, market allowances and baling charges account for about 20 per cent.

The jute crop in any year depends not only on the weather conditions at the growing period, but also on the price fetched for jute just prior to sowing. If the price is low the growers reduce the area under jute. Since they have no alternative cash crop, however, if prices remain low for a few seasons, they accept the low prices as being normal and gradually put more land under jute. Over a period, therefore, low prices alone do not necessarily mean a big reduction in the crop. In spite of the recent attempts to limit the sowings of jute in order to increase the production of rice, the sowings have seemed to be above those envisaged by the Government, no doubt because of the fact that the crop is the only cash crop available to the growers.

The preparation of jute is neither cheap nor easy. The harvesting and preparation must be done at the right time or the

quality of the fibre suffers. The crop is a bulky one and requires a comparatively large number of labourers per unit of area. Skilled labour is required for the preparation of the fibre, and since the preparation necessitates working in water for long periods under unhygienic conditions the wages paid are fairly high. Moreover, the time at which this labour is required coincides in some districts with the harvesting or transplanting of paddy, when the demand for labour is high, and wages are higher on this account also. On an average the labourers receive about Re. 0-6-0 per day, as well as two or three meals. In areas where labour is paid on piece rates, the pay is about Re. 0-3-6 for reaping and bundling, Re. 0-3-6 for steeping, and Re. 0-5-0 for stripping, for a "kori" of 20 bundles which yield about half a maund of fibre.

Cultivation

The cultivation of jute has been dealt with in the many publications on the subject and the following information is given merely as a guide to those who may wish to make preliminary investigations into the cultivation possibilities.

According to Finlow, the following conditions are required for jute cultivation:

(*a*) High temperature; (*b*) deep soil of fairly fine texture; (*c*) rainfall of over 40 in., so distributed that while the young plants have enough moisture, the bulk of the fall takes place when the crop is more mature; and (*d*) sufficient supply of clear retting water.

Jute thrives best in damp heat. During most of the growing season the minimum temperature is around 75° F., the maximum 95° F., and the humidity about 70-90 per cent. It is a crop for the rainy season and is sown from mid-February in the low lands to mid-June in the high lands according to the rainfall and soil, and harvesting is from the middle of June until September. A rainfall of 2 to 3 in. a month at the time of sowing and about 2 in. per week afterwards is suitable.

As regards soil, loam or sandy loam is most suitable. The greater proportion of jute in India is grown on grey soils containing little carbonate of lime, but good quantities of potash and satisfactory amounts of phosphoric acid. If the rainfall is too heavy and the soil too much saturated with water the sowings are retarded and it is difficult to weed and harrow. Soils in India where jute is grown are almost entirely alluvial, and are deltaic areas, with low altitudes, mostly below 50 ft. In the higher areas during the monsoon the higher lands are awash or covered temporarily with about 2 in. of water, while in the low areas the water level is high and the jute must, therefore, be cut in June before the water rises to about 6 ft.

The seed is sown broadcast after the land has been opened up by harrowing or ploughing. Two species of jute are sown, *Corchorus*

capsularis and *C. olitorius*. *Capsularis* grows equally well on both high and low lands, and yields a fibre which is normally white, and is known as "White" in the trade. *Olitorius*, however, does not thrive under flooded conditions and is cultivated in the high lands. The fibre from *olitorius* is obtained usually by retting in stagnant water owing to the lack of fresh running water, and although the fibre is often finer, softer, stronger and of better spinning quality than that from *capsularis*, its colour is either white, yellowish, pinkish, or blackish, according to the water used for retting. In the trade *olitorius* jute is known as Tossa jute. In 1937-38 it was estimated that of the total acreage under jute in India, 74·5 per cent. was under *capsularis* and 25·5 per cent. under *olitorius*.

By experimental work the Department of Agriculture in Bengal has evolved improved varieties of the two species. Two improved types, "D.154" from *capsularis*, and "Chinsurah Green" from *olitorius*, evolved by the Department, have become popular with growers, and in 1937-38 it was estimated that the improved varieties were under cultivation in about 80 per cent. of the total jute acreage in Bengal.

Capsularis has the advantage in that, being an early crop, in low areas it is sown from mid-February to mid-March to allow the plants to reach a sufficient height before the floods; it is harvested earlier and it is therefore possible for cultivators in Eastern Bengal to transplant paddy into the same fields as soon as the jute has been harvested; and if the ground does not remain submerged by flood water after August or September, a third crop, such as mustard or pulses, may sometimes be grown. In the case of *olitorius*, however, it can only be followed by a *rabi* crop. On the other hand, *olitorius* is able to withstand stem-rot disease and apion attack better than *capsularis*, and, since it matures later and grows taller, the maximum yields are higher.

The crop is weeded about three times and at each weeding the plants are thinned out, so that after the final weeding the spacings are 4 in. × 6 in. or 6 in. × 6 in. If the plants are too close together they are short and the outturn is less. It is stated, however, that a fibre which is finer and free from "root" is obtained from closely spaced plants. Spinning tests carried out by the Technological Research Laboratories of the Indian Central Jute Committee over a number of years have shown conclusively that the closest spacing of the plants, 4 in. × 4 in., give the best quality of fibre, and the widest, 9 in. × 9 in., the worst. Normally plants which are less than 3 ft. in height are not considered worth retting.

Most of the jute is harvested when about 50 per cent. of the plants are in pod, since at this stage both the yield and quality of the fibre are good. The yield of fibre obtained from plants harvested before this stage is lower and if harvesting is delayed until the seed pods ripen the fibre obtained is coarse.

Manuring

The manures generally used are cow-dung and wood ashes, and sometimes rotted water-hyacinth is applied to the fields. According to Howard, when nitrogen is applied to jute lands the plant grows more quickly and the yield of fibre is increased. On the other hand, too rapid growth yields a coarse fibre, and in this connection it is interesting to note that experiments carried out on the relations between the chemical composition of jute fibre and its spinning qualities by the Indian Central Jute Committee have shown that a high nitrogen content in the fibre is a probable indication that the fibre will be of low spinning quality. This may be due to the presence of extraneous nitrogenous matter in the fibre due to inferior retting or to the fact that if too much nitrogen is taken up by the plant its growth is too rapid and a coarse fibre, unsuitable for spinning is produced. It would be interesting to know what the nitrogen content of the fibre is at various stages of the plant's growth, e.g., before budding, at budding, flowering, etc.

Preparation of the Fibre

The plants, after cutting, are tied into bundles up to 9 in. in diameter. In some places the bundles are left for a few days to allow the leaves to shed, but in others the bundles are retted with the leaves on. The bundles should be at least 4 to 6 in. below the water, but should not be allowed to rest too near the bottom. At least 3 to 4 ft. of water is required for retting. The time taken for retting varies according to whether running or stagnant water is used, to weather conditions, and to the thickness of the stems. It may be from 12 to 25 days.

After retting the stems are stripped. About half a maund of fibre can be stripped by one man in a day. After stripping the fibre is dried in the sun for two or three days and, when dry, is made up into hanks, tied at the top end.

The yield of fibre varies from 10 to 20 maunds per acre, the average being about 15. In exceptional cases a yield of 50 maunds may be obtained. As regards yield, the thickness of the stem is more important than the height of the plant.

Quality of the fibre depends more on retting than on any other factor. Water with a high iron content darkens the fibre and over-retting weakens the fibre. If retting is too short the fibre does not become properly separated from the tissue in the stem and is inferior in quality.

Retting is likely to be better if the stems are of uniform thickness, since the retting period varies in different parts of the stem according to the thickness. In the top portion of the stem retting may be completed in about 5 days after steeping, in the middle in about 9 days, and in the bottom portions in about 15 to 19 days. For ideal retting the stems should, therefore, be of uniform thickness, and the best way to obtain this is by spacing the plants in the field

so that growth is as far as possible uniform, and by eliminating plants which are not uniform. Where the stems vary, the roots may be removed or the base of the stem may be steeped in water for a few days before the rest of the stem is immersed. With tanks, if the stems were stood upright, the depth of the water could be raised gradually so that the thicker parts of the stem at the bottom received the longer retting while the top received the least. When retting stems which vary in thickness some will be under-retted and some over-retted and the quality of the fibre as a whole will suffer.

Retting is due both to the effect of the water, which dissolves the soluble contents of the cells, such as gums, etc., and softens the tissues, and to the action of bacteria and fungi. From experiments made by the Indian Central Jute Committee, the organisms responsible for the retting of jute appear to be two bacteria and one fungus, which were all found in close association with each other, although it was not possible to say whether they are interdependent. In experimental rettings of *Hibiscus ponticus* in Russia, two types of bacteria were found, one of which was a facultative anaerobe and the other an aerobe. A pure culture of the first type was isolated and introduced at the beginning of retting of the fibre under sterile conditions, and it was found that the retting was speeded up and that the fibre was more lustrous. A pure culture of the second type, the aerobic type, when introduced in the same way, caused very little fermentation and did not hasten retting, although the resulting fibre was found to be softer.

The organisms which cause the retting of jute enter through the stomata of the stem and any cuts in it. The cambium is the first part to be attacked and the breaking down extends outwards so that the outer cells of the cortex are the last parts to become disintegrated.

Water Supply

Apart from the necessary climatic conditions, therefore, the production of jute requires a plentiful supply of suitable water for retting and a good supply of cheap yet relatively experienced labour, for retting and preparing the fibre. These naturally limit the areas in which it can be cultivated on a commercial scale, and are the chief reasons why up till now no other country has been able to compete with India in the production of jute.

In order to ret the green stems obtained from 1 hectare of jute it is estimated that about 300 to 400 cu.m. of water are required if the retting is done in tanks or ponds. Considerable water is also required for washing and stripping after retting. Since jute is a bulky crop, and is expensive to carry long distances for retting, the need for an adequate water supply fairly near at hand is obvious. In this connection, the use of static water tanks, such as were used in this country during the war for emergency supplies of

water, would form a suitable supply of water for retting. By means of strainers underneath it might be possible to drain off the water and use it again for further retting while the tank was cleaned out ready for use again. Such water would at least be cleaner and more hygienic than the stagnant water which is often used for the purpose. With such tanks it would be easy to raise the temperature of the water by some elementary form of heating underneath.

This question of water is most important, and applies not only to jute but also to the other fibres which are dealt with later in this article. At present the removal of the fibre from the stems of such plants is done by retting and then stripping. This process requires considerable labour and time. For example, it has been estimated that of the 500 working days which are necessary for the production of 1 ton of dry fibre, about 280 days are taken up in the transport, retting and stripping of the fibre. Any process which can produce a fibre, with its qualities unimpaired, by chemical or mechanical means, from the green stems of such plants at a reasonable cost might make the production of such fibres possible in countries where, up till now, the production has been uneconomic. If a machine, for example, could be moved to the various growing areas, to avoid the transport of the bulky green plants, it would be even more useful. Many processes have been put forward in the past, but as far as the Imperial Institute is aware, none of these has been used with success on a commercial scale. The addition of small quantities of chemicals in retting jute has been found to shorten the time required for retting, but it was thought that any process of chemical retting on its own would not be economical.

In paper-making, enormous quantities of water are required for the making of paper on the Fourdrinier machine. By a process of water recovery the bulk of this water is used again after it has been freed of fibre, etc. There seems no reason why a similar process of water recovery should not be used in the case of water used for retting where the water supply is not too plentiful. By such a method the temperature of the water could be maintained and also the bacteria and products which aid fermentation, so that the time required for retting might be actually reduced. Such a system, since it would require capital, might only be suitable for areas where the fibre crop is to be grown on a plantation scale, and where the retting is to be scientifically controlled. There does seem, however, to be scope for improved technique or methods in this stage of fibre production in particular, since retting is so important as regards the quality of the fibre produced, and since the process takes up time and labour which add to the cost of the product.

In the Argentine, after the plants have been retted, a machine, devised locally, is used to separate the fibre from the surrounding matter. The retting material is passed through revolving wheels with bars on them, so arranged that the jute is both scraped and

beaten as it goes under the different bars. The wood, etc., on the stems breaks, but the fibre, being flexible, resists. Fibre stripped by machine is not yet equal to the hand-stripped material, since the machine has a tendency to injure the fibre. As, however, the fibre is used for twine and for making soles of shoes for use locally, and not for bags, the machine has been found satisfactory.

Price

From the bag-making point of view jute is a strategic material. The cessation of supplies of jute for bags or of the bags themselves for even one season could have serious repercussions on the economy of a country producing as one of its major crops a product such as sugar. Without bags such crops cannot be transported, and lack of bags could mean the loss of the crop, at any rate from an export point of view. Any country which has a monopoly of the world's bagging material has, therefore, an important economic weapon, the use of which could cause serious damage for a year or possibly more, since it is impossible to grow and market a substitute in less than a year. Until the last war, jute had always been available at reasonable prices and in sufficient quantities to meet the world's demand. When, however, it became necessary to restrict jute sowings in India in order to increase the production of rice for food purposes, and supplies of jute became scarce, it was realised possibly for the first time how important bagging material is to countries producing food crops. Even in this country it requires about 20,000 tons of jute to transport the potato crop alone.

From the producer's point of view, a bag merely represents the container in which his commodity is conveyed to market. To the consumer it is satisfactory provided it delivers the product he is buying in good order and condition. It must, however, be as cheap as possible, and, even in normal times, when jute is comparatively cheap and in fairly good supply, there is a movement by users of jute bags to find a cheaper substitute, such as cotton or paper, when the price rises to a certain level. Local merchants in Calcutta are stated to have given the figure of Rs. 12 per 100 yd. for 8 oz./40 in. hessian (Calcutta price) as the level above which users seek a substitute. Much, however, depends no doubt on the prices which the producer is receiving for his crop, whether it be a raw material or a manufactured product such as flour.

Price, therefore, is important, and in this connection it is interesting to note that there have been suggestions recently, as there have been in the past, that the production of jute should be limited in order that the price may be kept up to give a better return to the jute cultivators. Under normal conditions, raising the price would tend to increase the production, especially since jute is the sole cash crop of most of the cultivators. There have also been suggestions, however, that in Bengal the jute industry may be

nationalised, in which case it may be possible to restrict the cultivation of jute effectively by making the Government or some other body the sole buyer of jute in Bengal, and making exports subject to licence.

It is difficult to forecast the future trend of any market, and in the case of jute it is practically impossible. The future of the industry in India will no doubt be affected by the new political changes. For example, about 80-85 per cent. of the raw jute is produced in areas which will come under Pakistan rule, while practically the whole of the processing side of the industry will come under the rule of India. Calcutta, too, the port from which jute is exported, will be in India. Whether the main producing area of jute will be content to let its raw material go to another area for processing remains to be seen. In any case, no quick change can be made since the jute cultivators have few facilities for storing jute, and are normally anxious to sell their crop as soon as possible and receive the cash. To set up spinning mills in Pakistan would take some time and considerable capital. Trade, however, has its own ways of overcoming barriers, whether they be political, religious, or national, and no doubt in due course the jute trade will get back to normal although its structure may possibly be somewhat changed during the transition.

Jute is one of the cheapest fibres, and, as has been mentioned, it owes its importance as a bag-making material to this fact. The following figures show the average values of jute, First Marks quality, per ton c.i.f. London, for the years 1932-38, compared with other vegetable fibres:

	Jute.	Manila Hemp J.2.	E. African Sisal No. 1.	Belgian Flax water-retted.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1932 .	16 18 0	18 15 0	15 2 0	86 10 0
1933 .	15 12 0	15 17 0	16 8 0	88 12 0
1934 .	15 10 0	14 18 0	15 9 0	90 7 0
1935 .	18 11 0	19 7 0	19 9 0	99 14 0
1936 .	18 7 0	28 5 0	27 9 0	95 18 0
1937 .	20 9 0	33 15 0	27 6 0	112 5 0
1938 .	18 12 0	21 17 0	17 10 0	111 2 0

The present high price of about £85 per ton c.i.f. is due, chiefly, not only to the short supply, but also to the high price of rice which is having to be imported into India to make up deficiencies.

It is problematical, however, whether the price of jute will go back to its pre-war level. No doubt the Governments of the various entities will endeavour to raise the standard of living of the people and to industrialise the areas over which they govern. In recent years India's industries have increased enormously and attempts are being made, with success, to manufacture many articles which were formerly imported. This is a natural tendency in a growing country and under the new organisation it will no doubt increase. If labour is attracted from the jute-growing areas to the factories, it may be more profitable for the cultivators to work in factories

than to produce jute at low prices. The actual producer of jute can do little to force up the price of his product. He cannot store jute for very long since he has no storage facilities, although a Committee of experts is being formed to advise the Bengal Government on the desirability of setting up warehouses in order to increase the holding power of the jute cultivators. While he is storing his jute he is in any case going without his cash, for which he is usually in urgent need since a large proportion of jute growers are in debt. According to a survey made in 1935, about 77 per cent. of the agricultural population in Bengal was found to be in debt. Since jute is the sole cash crop, and the creditors know that if their debts are not paid the grower will not be in a position to pay until the next crop, the creditors press for their payment as soon as the crop is harvested. Moreover, even if the growers could store their fibre, they depend so much on road and water transport for the marketing of their crop that they are obliged to sell it while the roads and rivers are passable. A review of sales during the 1937-38 season showed that in Eastern Bengal, for example, 38 per cent. of the sales by growers were due to financial reasons and 30 per cent. due to finance and transport, so that only 32 per cent. of the sales were not influenced by those factors. In many areas, too, owing to the lack of information and newspapers, the grower has very little idea of the state of the jute market in Calcutta.

Apart from any of these considerations, the market for jute depends on the market for bags, which in turn depends chiefly on the production of foodstuffs in other countries. If the crops in the producing countries are low there is less demand for bags and the market for raw jute is less. Consequently, there are fluctuations in the demand for jute in the various agricultural countries of the world, and over these the grower has no control. Any other means of obtaining cash without the responsibility and uncertainty of growing jute might consequently be attractive to the present growers.

Obviously it is to India's interest to go on supplying the world with jute and jute bags. In her foreign trade it occupies the leading position, and jute and jute manufactures account for about one-quarter in value of all exports from India, as can be seen from the following table taken from *Jute—Contribution to the Proposed Dictionary of Economic Products and Industrial Resources of India*, 1944, p. 62 (Indian Central Jute Committee).

RELATIVE VALUE OF THE JUTE EXPORT TRADE TO THE TOTAL EXPORT TRADE OF INDIA

	1937-38	1938-39	1939-40	1940-41	1937-38	1938-39	1939-40	1940-41
	Crores of Rupees.				Per cent.			
Total exports	181	163	204	187	100	100	100	100
Raw jute	15	13	20	8	8·1	8·2	9·7	4·2
Jute manufactures	29	26	49	45	16·1	16·1	23·9	24·3
Total	44	39	69	53	24·2	24·3	33·6	28·5

The Provinces of Bengal which are to become part of Pakistan grow about 80-85 per cent. of the Bengal production, or about 67 per cent. of the all-India production. From an export point of view, therefore, jute will be Pakistan's most important raw material, and much more important than it was even to an undivided India. If anything, therefore, the aim will be to increase the revenue from jute. This can be done by finding new uses for jute which will lead to an increase in demand; by restricting the production, hoping for an increase in price; by allowing production to continue without restriction and endeavouring to maintain the price at a high level by bargaining with jute in the world's markets. The best plan probably for India and for the world is to stabilise the price as far as possible at a level which is both satisfactory to the consumer and which gives a reasonable return to the grower. Once jute becomes too expensive it loses its one great advantage over other fibres which can be used for the manufacture of bags.

India herself has always been aware of the great importance of jute to her economy and of the danger of competition from other materials, and in recent years considerable research has been devoted to the improvement of strains, improvement in fibre quality and to an extension of the uses of jute, so that its supremacy as a bag-making material may be retained.

It is estimated that of the total number of jute looms in the world pre-war, 57 per cent. were in India. The next countries in importance, Germany and Great Britain, had 8 per cent. and 7·1 per cent. respectively. It can be seen, therefore, that from the bag point of view India also has a monopoly. Mill consumption of jute in India is well over half of the total production and exceeds the exports, as can be seen from the following figures taken from *Jute*, 1944, page 58 (Indian Central Jute Committee).

JUTE EXPORTS FROM INDIA

Year.	Exports (1,000 tons).			Percentage of Total.	
	Raw Jute.	Jute Manufactures.	Total.	Raw Jute.	Jute Manufactures.
Average of—					
1919-20 to 1923-24	554	709	1,263	44	56
1924-25 to 1928-29	768	857	1,625	47	53
1929-30 to 1933-34	665	748	1,413	47	53
1934-35	752	685	1,437	52	48
1935-36	771	752	1,523	51	49
1936-37	821	972	1,793	46	54
1937-38	747	1,020	1,767	42	58
1938-39	691	956	1,647	42	58
1939-40	570	1,078	1,648	35	65
1940-41	244	924	1,168	21	79
1941-42	317	897	1,214	26	74

The intake by the mills showed a tendency to increase before the war, and during the war years Indian mill consumption was

about four to five times the quantity exported. In view of the proximity of the Indian mills to the raw material supplies and of the large amount of capital invested in the industry around Calcutta, it would not be easy for any country to capture this monopoly. In fact, in recent years, it has been found increasingly difficult for some countries to manufacture jute on their looms at a price which will compete with imported jute bags.

In spite of, and also because of, India's natural advantages and her monopoly in jute and jute manufactures, attempts have been made in various countries to grow or use substitutes for jute. Some of these attempts have been made with a view to a policy of self-sufficiency on the part of the countries concerned, and others because they are producers of food-crops such as sugar and have endeavoured to meet their bag requirements from home-produced fibre. In the case of countries which depend for their exports mainly on food crops which have to be conveyed in bags, it is not unnatural that they should endeavour to safeguard their supplies of bags and, if possible, manufacture them from raw material produced at home, especially if such raw material can be grown possibly in rotation with the food crops. Moreover, in such countries there is also a demand for twine and string, which is often imported. The aim has been not to produce a fibre to compete with jute on the world's market, but to produce fibre primarily for their own use, and to establish a secondary industry either at home or in colonies to provide employment. This is quite a different proposition from the production of a fibre which is to be marketed in competition with jute on the world's markets and which must compete with jute as regards price and fibre qualities in those markets. In view of the chaos which a lack of bags for transporting food crops could cause in an agricultural country, the fact that very few countries have thought it necessary to produce their own bag-making material locally emphasises the extent to which the world has taken it for granted that large supplies of jute at low prices would always be available.

Storing of Jute

One obvious way of safeguarding supplies of bags is, of course, to build up stocks so that in years when jute supplies are short the stocks can be released to fill the demand and also to prevent violent fluctuations in price, especially if purchases for stock can be made when prices are low. The jute mills in India usually carry large stocks of raw jute at the end of the season, but as a rule the stocks held by consuming countries are not large. There is, however, not much information available regarding the effect of storage on jute. It must be stored dry, otherwise damage occurs to the fibre, especially in the interior of the bales. There is also a loss in weight due to evaporation of moisture, which is estimated by some mills to be about 1½ to 2 per cent. Some grades of jute store better than

others. Hard jute, white quality, from Eastern Bengal, for example, when stored for three years retained its strength fairly well and also its colour, except where the outsides of the bales were exposed to the air. On the other hand, tossa and soft Northern qualities deteriorate quickly even if stored under ideal conditions. Some time ago the Technological Section of the Indian Central Jute Committee were stated to be making investigations into the storage properties of jute.

Cultivation of Jute outside India

Jute has been cultivated for some years in countries outside India, although the extent of such cultivation compared with India's production is negligible. Small quantities have been grown in French Indo-China, Japan, Manchuria and Formosa, as well as Brazil. In the two last-mentioned countries, however, the production has increased in recent years and in Formosa the crop was about 30,000 tons in 1939, while in Brazil the production, which was only 100 tons in 1940, had increased to 8,000 tons by 1945.

Trials with Jute in the British Empire

As regards the British Empire, many attempts have been made in the past to grow jute, but without any permanent result. This has been due to a lack of water for retting and to the costs of labour which have been too high for the fibre to be obtainable at a price which would enable it to compete with the product from India.

There are several places in West Africa where it could be cultivated, and **Nigeria,** in particular, along the lower regions of the Niger, seems most suitable. Jute was cultivated in West Africa in 1896, when large quantities of seed were supplied to several places on the coast. It was shown that fibre of good quality could be produced, but the experiments were on too small a scale to show whether it could be developed economically. The following is a brief review of the past experiments in jute growing in the Empire:

Gambia.—Trials were made in 1897 and strong, good spinning, well-prepared fibre was produced. The yield per acre was too small and the cost of production too great for the crop to be produced economically.

Sierra Leone.—Results were not very successful, chiefly due to the ignorance of the natives with regard to the methods of cultivation and to the fact that no fertiliser was applied to the soil.

Southern Province, Nigeria.—Samples of the fibre were received at the Imperial Institute in 1896 and again in 1907. On the whole, the fibre was fairly satisfactory, although in some cases it had been over-retted.

Northern Province, Nigeria.—Fibre from this region was reported on as being very suitable for spinning and worth £24 per ton, compared with medium qualities of jute at £23 to £25 per ton.

One species of jute (*Corchorus tridens*), which grows wild in

Nigeria, was found to give good results under cultivation, but the Imperial Institute has no information regarding the quality of the fibre obtained from this species.

Nyasaland.—Trials were made with *Corchorus capsularis* in 1926 and the fibre obtained was said to be very clean provided the retting was done at flowering time. If left after flowering it was found that the stems took longer to ret and that the colour of the fibre was inferior. The yield was about 500 lb. of clean fibre per acre.

Samples of jute have also been received at the Imperial Institute from Rhodesia, the Union of South Africa, and Fiji. In **Uganda** trials with *C. capsularis* were not promising and the plants only grew to a height of about 3 ft. and were attacked by eelworm.

The jute plant is native to the **Sudan**, where in some parts it flourishes in its wild state. Agriculturally the country is suited to jute, but the development of a jute industry there, however, is dependent on the invention of machinery which will decorticate and extract the fibre efficiently.

There seems no doubt, therefore, that jute could be cultivated successfully in one or other of the British Colonies. As has been stated, however, the chief difficulties in the past have been the large amounts of water required, and the higher cost of production compared with Indian jute. If the price for Indian jute is to be kept at a higher level, however, the cost of production in other countries may not be so unfavourable.

Substitutes for Jute

Although at various times many fibres have been suggested as substitutes for jute for bag manufacture, very few have actually become of any commercial importance. One of the chief reasons for this has, of course, been that in view of the low price of jute and the large quantities available, there has been no incentive to produce other materials. Apart from this factor, most of the fibres which have been suggested either require a somewhat different batching treatment from that which is given jute, or cannot be spun on jute machinery. While jute has been available at reasonable prices and in large quantities, spinners naturally have had no incentive to experiment with other fibres, the price and quantities of which have been uncertain. For this reason, in countries such as New Zealand, Mauritius, Java and Brazil, for example, where local fibres are used in place of jute, the spinning of the yarn and the manufacture of the bags is done on the spot.

The chief disadvantages of most of the fibres suggested as jute substitutes are their inferior strength and suppleness. It should be possible, however, to use many of them for weft yarn and use jute for the warp yarn since the warp yarn must be strong. This would restrict the demand for jute and enable local fibres to be used. More care in the preparation of the fibres, in particular in

the retting, would also encourage the use of these other fibres, since in some cases the difficulties met with in spinning the fibres are due as much to bad preparation as to the inherent properties of the fibres. Uniformity of quality from shipment to shipment is also very important, since manufacturers cannot be expected to vary their technique for each shipment.

If substitutes are to be grown in any country, the fibre to be used will depend naturally on the climatic conditions, etc., and also on whether it is desired to obtain a substitute for jute as quickly as possible or whether the object is to make the country self-supporting as regards bag manufacture in the future. If the object is to provide a jute substitute as quickly as possible, then it is obvious that the plant chosen should yield fibre within the shortest possible time. This rules out such fibres as Mauritius hemp, *Phormium tenax*, or sisal, from which no results can be expected within four to five years. They may be suitable for long term policy, however, more so since they lend themselves to mechanical methods of decortication, etc., and since, by careful cutting of the leaves, a more uniform fibre can be obtained. Where results are needed quickly, plants such as *Urena*, *Hibiscus*, etc., which are grown as annuals, should be chosen.

Cotton.—Of the substitutes for jute which have been used commercially in recent years, cotton and paper are the two most important. In the United States of America and the Argentine cotton is being used for packing sugar, flour, fertilisers, cement, etc., and for linoleum backings. Cotton makes a more attractive packing medium than jute and such packings are little affected by moisture, and have a higher salvage value. Normally cotton is more expensive than jute, but where it is desired to make full use of a crop grown locally, price is not so important. In the United States of America the manufacturer is, by subsidy, able to market his cotton bags at prices which are approximately the same as non-cotton packages.

Paper.—Before the war paper was being used on an increasing scale in Western countries as a substitute for jute, in particular for packing cement, and it is doubtful if jute will ever regain its lost position in this sphere. Unfortunately, however, in view of the dependence of the British Empire on foreign sources of supply for wood-pulp for paper, the use of paper as a substitute for jute is not likely to increase at present for currency reasons.

Synthetic Fibres.—Synthetic fibres have, of course, possibilities as jute substitutes, but at present their price is much too high to enable them to compete with jute. "Fibro," for example, which is a staple rayon fibre, and which is cheaper than ordinary rayon, is being used for some purposes for which jute was normally used. The advantage of staple fibre is that it can be spun on machinery which is used for jute, cotton, etc. A disadvantage as far as this country is concerned, however, is the fact that the raw material for the manufacture is obtained by imports from hard currency

countries. In Germany before the war, a jute substitute, known as "Zell jute," was said to be made from straw pulp. The cost was about three times that of jute, although it was hoped that better methods of production would bring the price down. It would appear, however, that the material was not very satisfactory, since during the war the material was made from digested wood pulp and not from straw. The material from wood pulp was not a success and only one spinner was making a satisfactory yarn. According to the conclusions of the *B.I.O.S. Report No.* 198, *Item No.* 22, entitled *German Jute Industry*, the spinning of Zell jute had not been properly studied in Germany and the investigators suggest that the British jute industry might consider the possibilities of viscose rayon staple fibre as a jute substitute in case the supply of jute should fail at any time.

Other more important fibres which have been used in place of jute are *Urena lobata*, various species of *Hibiscus* and Caroa fibre, (*Neoglaziovia variegata*). The following account of the cultivation, etc., of these fibres is not intended to be exhaustive, but is given merely as a guide to those interested in their possibilities.

Urena lobata. Production of this fibre was commenced in the Belgian Congo towards 1929 and has increased considerably since then. In 1933 exports were about 150 tons, but in 1943 the production was about 13,000 tons. Shipments to the United States of America in 1947 were expected to reach this figure.

By improved methods of cultivation, careful study and efficient supervision and guidance with the retting of the fibre, the quality has been improved considerably. Until the war, much of the grading was done by the jute mills in Belgium.

During the war, when shipping from Calcutta became difficult, manufacturers in the United States of America began to show an interest in the fibre, and in 1943 it was arranged that they should buy all the fibre available from the Belgian Congo. A very recent report states that plans are now being made to process *Urena* in the Belgian Congo, although it is not known as yet when the mill will begin to operate.

Production of *U. lobata* has also been encouraged in Brazil, and in 1945 the crop was expected to be about 2,500 metric tons. Cuba, too, has been making experiments in the cultivation of this plant. Before the war a factory was making bags from the fibre in Madagascar, and production in 1939 was stated to have reached about 3,000 tons.

In Madagascar, natural stands of *U. lobata* are mainly used, and, by law, cutting of the plants between January 1 and May 31 is forbidden in order to conserve supplies. The fibre is made into bags locally, but the cutting of the wild stems is stated, however, to be not completely satisfactory, since the fibre is not too uniform and consequently not too attractive to European manufacturers who have become accustomed to properly graded Indian jute.

In order to ensure a proper outlet for the fibre a system of planned cultivation such as is practised in the Belgian Congo is necessary.

Of all the fibres which have been suggested as substitutes for jute, it is probable that *U. lobata* is the most promising, although it has certain hemp characteristics. The fibre is fine, soft and lustrous and has good spinning qualities. Apart from the question of the use of the fibre to replace jute, it can be used for textile purposes, ropes, carpets, packing materials, upholstery, etc., or in admixture with other materials.

Urena lobata in the British Empire.—Although *U. lobata* occurs in many parts of the British Empire, e.g. India, Australia, various parts of Africa, British West Indies, etc., up till now it has not been cultivated on a commercial scale. Trials made in British Guiana showed that it was difficult to establish and that under cultivation the plant seeds rather sparsely. Although it is indigenous in East Africa it only grows to a height of about 2 to 3 ft. A sample of *U. lobata* received at the Imperial Institute from the Gambia was reported on by the trade as superior to medium quality jute, but it was only about half the usual length of jute. It is worth while pointing out here that whatever fibre is chosen, the object is to grow, not so much a plant, as a fibre, and the conditions of cultivation must be such as to produce the highest possible yield of good quality fibre from a given area.

In Trinidad, where *U. lobata* occurs in natural stands, it was found that, based on the yields of these stands, the cost of production could hardly be less than about 5 cents per lb. when the market value for export was about 2½ cents per lb. Samples of the fibre obtained from naturally growing plants were reported on favourably in this country and the United States of America and were considered to be equal to jute. Trial plots were to be planted in 1939 to see whether increased yields could be obtained when the plant was cultivated.

Cultivation of Urena lobata.—The following account of the cultivation of *U. lobata* is derived mainly from an article in the *Bulletin Agricole du Congo Belge* (1940, 26, 14-40.)

U. lobata requires a hot and humid climate with alternate sun and rain. In an equatorial climate the plant will grow at any time of the year, but if the region has a dry and wet season, the growth of the plant will take place during the wet season and fruiting during the transition period. The equatorial forest regions are less suitable than other parts of the tropics since the very heavy and frequent rains in such areas are harmful to the development of the fibre.

The plant has a tap root about 20 to 40 cm. long and a secondary root system which is horizontal and running, the axes of which decrease in depth. These lateral roots are able to assimilate nourishment as far as 1·50 metres from the plant. The plant, therefore, obtains its nourishment from the superficial layer of the soil, and

in view of its quick growth it requires readily available materials in a form in which they can be easily assimilated.

The soil should be rich, loose and with sufficient nitrogen (especially during its early stages of growth), phosphates and lime, while potash is particularly important. Too much nitrogen, however, produces luxuriant vegetation but inferior fibre. *Urena* will not tolerate acid soils. The soil should be loose and well drained, and in this respect it differs from jute in that although the soil must always be very moist, the plant cannot withstand partial submersion as can jute. The subsoil can be very moist, however, provided the upper 30 to 40 cm. are well drained.

The ground must be well ploughed, the deepest ploughing giving the best results. The earth should be reduced to a fine tilth because of the small size of the seed. If the ground is newly broken savannah it is advisable to grow in the first year a crop which will stifle weeds.

It should be mentioned that, although *Urena* grows in many soils which are not suited to it, if economic yields are to be obtained it is important that it should be grown where conditions are suitable.

The seeds should be sown at the beginning of the wet season after 30 to 40 mm. of rain have fallen. They should be soaked in tepid water for 24 to 48 hours to hasten germination. The hooks on the seeds can be removed by rubbing between the hands or in sand. If they are not removed the seeds tend to cling together and proper sowing may be difficult. In the Belgian Congo the amount of seed suggested is about 70-90 kg. per hectare (60 to 80 lb. per acre). In Cuba the amount suggested is 36 lb. per acre. The depth of the seeds should be about 1-2 cm. and after sowing the ground is lightly rolled.

The plant will tolerate full sunlight but not shade. Under favourable conditions and according to the weather, the seedlings appear about eight days after sowing. Growth at first is slow and the young plants are quickly stifled by weeds. Weeding should, therefore, be carried out two to three weeks after the seedlings first appear and a second weeding about one month after the first. When doing the second weeding the opportunity can be taken to thin out plants which are too close together. In the Belgian Congo it has been found that the highest yield per hectare is obtained if the plants are about 6 cm. apart. Close spacing prevents the plants from branching laterally and producing shorter fibres.

Under normal conditions the growing time for *Urena* is about four to five months. The plants are cut when in full flower and are then 6 to 8 ft. high. If a whole field cannot all be retted at the same time it is advisable to sow in " parcels " with a suitable interval between each. A second cutting is usually obtained from the same plants in the year. Although the plant is a perennial it does not stand repeated cutting and should, therefore, be grown as an annual.

Urena is very exhausting to the soil and some system of crop rotation is essential if good yields are to be obtained. In the Belgian Congo the following rotations have been suggested.

Forest soil	1st year	Urena.
	2nd ,,	Cassava with bananas.
	3rd ,,	Cassava with bananas.
	4th ,,	Bananas.
	5th ,,	Fallow.
		or
	1st year	Maize followed by haricot in the dry season.
	2nd ,,	Urena.
	3rd ,,	Cassava.
	4th ,,	Cassava.
	5th ,,	Fallow.
Good Savannah or Alluvium	1st year	Groundnuts.
	2nd ,,	Urena.
	3rd ,,	Sweet cassava.
	4th ,,	Green manure or legumes.
		or
	1st year	Maize followed by tobacco in dry season.
	2nd ,,	Urena.
	3rd ,,	Bananas.
	4th ,,	Bananas.
	5th ,,	Fallow.

Retting may be done either in running or still water or in tanks. Each method has its advantages and disadvantages. Retting in running water gives a whiter fibre since the waste products are carried away. The fibres obtained are firmer, and the temperature of the water varies within fairly narrow limits. On the other hand, retting in tanks is more rapid since the temperature of the water is higher, and the establishment of holes or tanks near the fields diminishes the time and cost of transport of the stems from the fields. Retting done in still water, however, is less hygienic than that in running water and where tanks or ponds are used the natives should be urged to do the separating, etc., of the fibre out of the water.

Whatever method of retting is used, the procedure is much the same. The bundles of fibre, about 20 to 25 cm. in diameter, are immersed under the water at least 10 cm. from the top to avoid the action of the sun and weighted down with stones, etc. If the bundles are exposed to the air or the sun, spots are formed on the fibre which lower the strength and the value. The time taken for retting varies according to the conditions, but under normal conditions is from 8 to 12 days in the warm season. In cold weather it may take up to 20 days.

After retting the fibres are removed from the surrounding material by hand and washed in clean water. After washing, they are put out to dry on lines, etc., care being taken that they are kept clean. After drying is complete the fibres are made supple by vigorous and repeated rubbing, which also helps to remove any impurities attached to them. The fibre is then graded according to quality, colour and length, and pressed into bales.

The yield varies according to the size and height of the plants and the area in which the plant is grown. A good native field is stated to yield easily 800 to 1,000 kg. of fibre per hectare, although yields can be much greater. If selected seeds are used for sowing the average yields can be increased to 1,500 kg. per hectare under native cultivation. The yield of fibre from the green unretted stems is on an average 5 to 6 per cent.

Hibiscus cannabinus (Deccan Hemp, Bimlipitam Jute, Dah, Guinea Hemp, Kenaf).—There are several varieties of *Hibiscus cannabinus* occurring in the various countries where it is grown, and there are wide differences in the growth period and requirements of these different varieties which are of importance from the economic point of view. The varieties may be distinguished from each other by colour, thickness of stem, leaf form, blossoms and seed. For fibre production the best varieties are said to be those with green stems such as *viridis* and *vulgaris*. Those with red or purple stems, such as *simplex*, *ruber* and *purpurea*, are stated to be unsuitable for fibre purposes.

Cultivation.—*Hibiscus* species seem able to adapt themselves fairly well to a wide variety of soils and climatic conditions, but are sensitive to frost, and are, therefore, better suited to cultivation in tropical or sub-tropical regions. The plant is reported as growing in the lower Himalayas up to elevations of 3,000 ft. or higher. Heavy rains or strong winds beat down the plants and make harvesting difficult. An adequate rainfall over a four to five months period is necessary, but well-drained soil is essential or the plants remain stunted and are apt to die before flowering. The tap-root of *Hibiscus cannabinus* penetrates deep into the soil and the root system is much deeper than that of *H. sabdariffa*. In order to allow the tap-root to develop well and to allow aeration to the roots, the seed bed should be well prepared and dug to a depth of 8 to 15 in. The plant is very sensitive to changes in the aeration of the soil. For fibre purposes it is essential that the growth of the plant should be uninterrupted and for this reason it should be planted at the beginning of and grown during the rainy season. The temperature of the soil has considerable influence on the germination of *H. cannabinus* seed. If it is sown in cold soil the seed takes a long time to germinate and may die. In Russia it was found that the best period for sowing was when the soil at a depth of about 10 cm. had been warmed to a temperature of about 14° to 16° C. In the first few weeks of growth the areas around the plants should be well weeded, but after the plants are about 2 to 3 ft. high, weeding can be discontinued.

There is some difference of opinion as to when the plant should be cut to obtain the best fibre, but the weight of opinion seems to agree that the plants should be harvested when they are flowering and at the latest as soon as the seeds are mature. As far as the Imperial Institute is aware, no spinning trials seem to have been

made with fibre obtained from plants cut at different stages of flowering and seeding, and if production of the fibre is contemplated on a commercial scale in any country, it might be worth while having such trials made as part of the preliminary investigations. Samples of the fibre obtained from plants cut before flowering, at the beginning of flowering, and at flowering time, have been compared at the Imperial Institute in the past, and from the chemical analysis it seemed probable that the best time for harvesting the plant was during the flowering period. The fibre spinner, however, is more interested in the way the fibre works in the mill and for this reason actual spinning trials might be a more useful guide. Fibre obtained at the time of the appearance of the first capsules is more a spinning fibre, while that cut at the end of fruiting is a lignified and harsh fibre which is more suitable for rope-making.

In India, tests made with jute harvested at different stages of the plant have not been too conclusive. It was found that a good quality fibre could always be obtained if the plants were harvested when they were in bud, but whether a better fibre could be obtained if harvesting was left until the plants were in flower or until the seed pods had formed appeared to depend on the particular season. In some cases an extremely high quality fibre was obtained from plants which had been harvested earlier than usual.

In harvesting Hibiscus the plants are either cut or pulled out of the ground. Cutting is said to be best since the fibre is then free of the coarse fibre which occurs at the base of the stems, and the roots left in the ground serve as humus from year to year.

To ensure a sufficient supply of seed for future crops, it would be necessary to grow a certain number of plants under different conditions for seed purposes only. For seed purposes the plants need to be spaced further apart and are, of course, harvested later than when they are grown for the fibre. After harvesting, they are dried for a few days and the seed can be threshed out by beating the stems. As regards flowering and fruiting, *H. cannabinus* and *H. sabdariffa* differ in that the former does not exhibit marked photoperiodism whereas the latter flowers according to the season regardless of the time of planting. This fact is important when considering which of the two plants should be cultivated.

Retting.—After harvesting the stems are retted in water. The retting period varies, among other things, according to the time at which the stems have been harvested, the water used, whether stagnant or running, and the temperature of the water, and may take between 5 and 22 days. When retting is completed the stems are removed from the water and the fibre is removed by hand, washed in clean water and dried in the sun. In the United States some *Hibiscus cannabinus* has been retted by dew, and this might be a possibility where water supplies are not too adequate. No information is available regarding the properties of dew-retted

Hibiscus, however. Hemp is of course retted by dew and snow in some countries. The yield of fibre per acre varies considerably, from 1,000 lb. to 6,000 lb., according to the time of cutting, soil, method of cultivation, etc. In connection with yield it should be borne in mind that up till now cultivation of Hibiscus has for the great part been carried on as a peasant industry, the fibre being grown for local uses. No doubt with more scientific cultivation such as is given to other economic crops, and with proper manuring and rotation from year to year, the yield of good quality fibre could be increased.

Hibiscus cannabinus fibre in comparison with jute is somewhat coarser and less supple, but has more tenacity and lustre and is more resistant to rot. From inquiries made in the past it appears that jute spinners do not particularly like the fibre since it is rather woolly, and not so easily spun as jute. In its properties *H. cannabinus* is nearer to *Abutilon avicennae* than to Indian jute, and more suitable for cordage than for textiles. It is not so fine as jute, but has a high breaking strength and breaking length. For spinning it needs careful breaking and oiling and is difficult to work, even then. Opinions as to whether it is as flexible as jute seem to differ. Jute itself is marketed in many different grades and it is necessary to know, therefore, when reading reports of the comparison of other fibres with jute, what grade of jute is meant. This is not always made clear, and it is no doubt true that *H. cannabinus* is equal to some of the coarser grades of jute although not equal to the best.

It could be used, however, for heavier sacks. Much depends on the conditions under which it is cultivated. The plant is grown on a small scale in many countries and used by the natives for making rope, twine and fishing nets.

Generally, therefore, *H. cannabinus* can be spun on jute machinery without much modification, but, as with all fibres, the properties vary considerably according to the area in which it is grown, the rate of growth, spacing of the plants, time of cutting, and the retting given to it. If grown under favourable conditions, and properly prepared, *H. cannabinus* can be used for most of the purposes for which jute is used, but on account of its inherent properties cannot be spun down to the fine counts required for some special purposes for which jute is used. It is essential, therefore, that preliminary spinning trials should be made with fibre from a particular area before any large scale cultivation is undertaken. Bags made from Hibiscus fibres are harsher than those made from jute.

In the Union of South Africa seed of *H. cannabinus* and of *H. diversifolia* is being collected with a view to growing the plant for fibre, and presumably it has been ascertained that the fibre obtained from this seed will be suitable for spinning. Wild plants, however, are often not suitable for fibre production. In the *Hibiscus* species

crossing takes place easily, and if the plant is to be grown on a commercial scale in areas where the plant grows wild as well, the danger of crossing with the wild species must be taken into account. Farmers are being guaranteed £20 per bag for first grade seed, and 200 bags have been collected, sufficient to plant 1,000 acres, which will yield, it is hoped, about 1,000 to 1,500 tons of fibre. The fibre will be made into bags at the factory recently set up at Benoni, on the East Witwatersrand. The areas chosen for the production of the fibre are Barbeton, Kaapmuiden and Nelspruit, where the climate is suitable and where plentiful supplies of water are assured. A site of about 20 acres is being taken over on the banks of the Crocodile river, where it is proposed to erect retting tanks, a decorticating plant, and the necessary buildings. Trade reports state that the seed will be issued to farmers at a price of £22 per bag of 203 lb., and that the producers will be paid about £6 per ton of air-dry stalks. It is estimated that farmers will make a net profit of at least £24 an acre. Other reports state that the cost of retting by the farmer will be between £10 to £15 per ton. The textile company which is to process the fibre has been guaranteed £200,000 by the Union Government. There seems to be some apprehension in certain parts of the Union, however, that unless the cultivation of the plant is controlled there is a danger that it may become a troublesome weed, especially if on account of lack of labour and a fall in price of the fibre the crop were to be left unharvested and allowed to spread as a weed. This attempt by the Union to replace imported jute bags by bags produced from locally-grown fibre will be followed with great interest.

The Union Government is also planning to plant 1,500 acres with *Phormium tenax*. During the war, according to a trade report, several hundred acres were planted under Phormium in Zululand. The chief drawback to the use of Hibiscus in the past has undoubtedly been due to a large extent to the lack of care given to the retting and preparation of the fibre. It is interesting to note that, from inquiries which were made by the Special Committee on Jute and other fibres appointed by the Committee for India of the Imperial Institute in 1919, it seemed quite clear that the sand and mud adhering to Hibiscus fibre was responsible for the lack of interest shown by spinners in the fibre, and that if these defects in the preparation of the fibre could be removed there was no reason why spinners in Dundee should not be able to use large quantities of the fibre. The Committee in their Report suggested that the fibre could be used for mixing purposes to a much greater extent both in Dundee and on the Continent, and that benefit to the jute trade would result from the extended production of the fibre for export. It was suggested that cultivation of *Hibiscus cannabinus* should be encouraged in areas which were not suited to jute. During 1940 to 1942, when jute supplies were cut off, the fibre was used in spinning mills in France without any great difficulty. There

were complaints, however, that the fibre contained 5 per cent. of "foots" instead of the 2 per cent. allowed, but since the most mediocre fibres were being used this was not a serious defect. *H. cannabinus* is cultivated in Madras as an annual, and to some extent in Bombay, Hyderabad, Central Provinces and Bihar, about 150,000 to 300,000 acres being under the crop, and is exported under the name of "Deccan hemp" or "Bimlipitam jute." It also grows wild in many other Empire countries and in the Transvaal and Natal it is regarded as a troublesome weed.

About 20 years ago a small company was formed in the Union of South Africa for the purpose of cultivating the fibre and using it for the manufacture of maize bags. The enterprise seems, however, to have been unsuccessful. Samples of the fibre have been received at the Imperial Institute in the past from the Sudan, Gold Coast, and Rhodesia. In Nigeria it grows wild, and, according to reports, has been used to make excellent sacks. *H. cannabinus* grows in several districts in Russia, and in 1931 production of the fibre for sacks was about 3,500 tons. In 1933 plans were being made to put 1,500,000 acres under Kenaf. It is also cultivated extensively in Manchuria and just before the war about 25 per cent. of Manchuria's jute requirements were being met by Kenaf.

Incidentally, the suggestion has been made quite recently that India should use *H. cannabinus* for the production of coarser and cheaper bags for export.

Roselle (*Hibiscus sabdariffa* var. *altissima*).—The plant is sensitive to frost and tropical or sub-tropical countries seem, therefore, to be the most suitable areas for cultivation. The quality of the fibre is best when the growth of the plant is uninterrupted, and the ideal environment is one which promotes continuous and rapid growth of the plant. It is stated that the plant can be cultivated up to 1,900 to 2,300 ft. above sea-level in coastal areas near the Equator. Provided the climatic conditions are favourable, altitude is not of great importance. High winds are unfavourable to the growth of the plant since the long stems which are required for fibre production are easily damaged by winds. Rainfall should be between 60 to 80 in., well distributed during the rainy period, about 10 in. of rainfall per month during the growing period being the optimum amount necessary. As regards soil, this should be moderately fertile, well-drained and permeable. The plant needs nitrogen and potassium in fairly large quantities. In El Salvador it has been found to grow quite well on acid soils, and in Guatemala on alkaline soils.

Preparation of the seed bed requires special attention, and the soil should be ploughed rather deeply to a depth of at least 8 in., and, if possible, 16 to 18 in. It is important that the seed bed should be uniformly prepared so that a uniform stand of plants giving as far as possible a uniform quality of fibre can be obtained. In this connection, too, it is important that pure seed should be used.

If seed of different varieties of the plant is grown the fibre will be of uneven length and quality. The spacing of the plants is important since if they are spaced too far apart they will tend to branch. The weight of opinion seems to agree that roselle should be planted at the beginning of the rainy season. The plant, however, does not flower or fruit until the short days, regardless of the time of planting, and the time of planting is therefore most important.

As in the case of *H. cannabinus*, there is some difference of opinion as to when the plants should be harvested for the fibre. The older the plant the higher the yield of fibre, but it would appear that after a certain time the fibre becomes coarser and of inferior quality. Here again, the best time for harvesting would have to be determined by experiment. Cultivation experiments in Java show that roselle needs plenty of water for fibre production, and also good soil and considerable care in cultivation. In Java it takes seven or eight months to grow and this means that the land is occupied for a considerable part of the year and cannot be used for food crops. Any success achieved in the production of the fibre in Java is due considerably to the fact that the fibre was used by bag factories on the spot, and in 1939 it seemed doubtful whether the production of the fibre was a paying proposition to the native growers who were producing the inferior grades of fibre. The price of a roselle bag was said to be 3 to 3·50 Fl. cheaper than a jute bag. To increase production it was proposed to encourage the making of roselle cloth as a home industry.

Weeding in the early stages of growth of *Hibiscus sabdariffa* is important, otherwise the weeds are likely to choke the plants. After about a month, however, when the plants are established, weeding is difficult and can be dispensed with.

The time required for retting roselle fibre varies, according to local conditions, from 5 to 20 days. Much depends on the temperature of the retting water, whether the retting water is stagnant or running, and the age of the plants when harvested. The tank capacity required for retting 1 acre of roselle naturally varies according to the yield per acre. Estimates vary from 700 to 850 cu. ft. per acre. In any country where it is proposed to produce the fibre a certain amount of experimental retting will need to be done in order to ascertain the best conditions for retting in the area. The lower part of the stem requires longer retting than the upper and it is suggested that in the first place the stalks should be stood in water with the lower part submerged in order to allow it to undergo a certain amount of retting before the whole stem is immersed.

Up till now no really satisfactory method has been found of extracting the fibre other than retting. Fibre obtained by mechanical decortication is not so good as that obtained by ordinary retting.

The yield of fibre varies according to the soil, climatic conditions,

etc., from 600 lb. to a ton or more per acre. About 1,500 lb. of dry fibre per acre seems to be an average figure. In British North Borneo, where interest in the cultivation of the fibre was shown at one time, it was found that 30 stems were required for the production of 1 lb. of fibre.

Owing to the fact that the fibre from the plant varies according to the area in which it is grown and the methods of cultivation and preparation, opinions on the utility of the fibre differ. It requires better softening before spinning than jute, but provided it is properly prepared, however, and harvested at the most favourable time, there seems no doubt that the fibre, although it is less flexible than jute, and although it cannot be spun so fine as jute is for fabrics, etc., can be used for most purposes for which jute is used, in particular for bag-making.

Roselle needs longer batching than jute. Investigations on the fibre from the Dutch East Indies have shown that with a batching emulsion of 73 per cent. water, 6 per cent. mineral oil, and 21 per cent. of animal oil and soap, the material needs to be left for 46 hours instead of about 24 hours which jute requires. It absorbs about 40 per cent. of the batching oil, compared with the 20 per cent. absorbed by jute, although it dries more quickly than jute. The first treatment in the batching is to pass it through the softener dry, and then again after it has been sprayed with the emulsion. It was only possible to spin Nos. 4 and 3 yarns with the fibre on its own, on 5 in. machines with 64 spindles. The conclusions reached were that the fibre can be spun with jute and from the point of view of colour this would be an advantage since the chief difficulties in spinning roselle on its own are due to the inferior suppleness of the fibre compared to jute, and since this is influenced by the fineness of the fibre, which is also less than jute, it was concluded that the aim of the planter should be to breed a finer and more supple fibre. The breaking length of the warp yarn is less than that of jute and the fibres do not fit in so well with each other, so that the outer ones do not support those on the inside. However, the fibre is found to be quite suitable for the manufacture of sugar bags in the Netherland East Indies, and in 1939 about a quarter of the total bag requirements of the Netherlands industries was made of roselle. In Java the manufacture of bags from the fibre was aided by a Government subsidy and just before the war it was hoped that the production of roselle would eventually make Java self-supporting as far as sugar bags were concerned. In the United States of America at one time it was considered that the fibre was too webby for machine spinning, but trials there during the war showed that it could be spun on jute machinery. As far as durability goes, roselle is reported to be as good as jute.

The plant occurs in many countries in the Empire, and North Borneo is stated to be particularly suitable for the production of

the fibre. Trials made in the Federated Malay States and in Ceylon some years ago gave very encouraging results. The plant is widely grown in West Africa, where the calices are used, either fresh or dried, in soups, etc.

Mechanical Harvesting and Decorticating.—In the last few years experiments with roselle have been made in Cuba, Nicaragua, Guatemala, Costa Rica, Honduras, Colombia and El Salvador. Under favourable conditions, in Cuba the plant grows as high as 10 ft. in about 90 days. Mechanical methods of harvesting are being tried in Cuba for *H. cannabinus*, and machinery which was used for harvesting hemp in the United States of America has been adapted for the purpose. The machine works best with plants that are about 110 days old and which are planted in rows about 8 in. apart, and which are about 8 ft. high. The harvester can cut about 1 acre per hour. In Cuba, too, henequen decorticators have been used to extract the fibre from roselle, and by using these decorticators the bundles of roselle are brought from the field and put through the decorticator, which scrapes away the woody cylinder and extraneous matter and leaves the clean fibre, which is then dried in the sun. The machine deals with about 1,500 lb. of dried fibre per hour, so that a large quantity of green plants is necessary to keep the machine fully employed for any length of time. From the reports available, however, it appears that the fibre obtained by the machine is more harsh, less lustrous, and not so free from gummy matter as the retted material. Latest reports are to the effect that further experiments are necessary with decortication before the methods can be used commercially.

If, however, machines for efficient harvesting and decortication of roselle and Kenaf can be obtained it would open the way for the production of the two fibres on a plantation scale.

When mechanical methods are not used, after retting, the fibre must be stripped from the stems by hand or by beating. If the whole stem is retted, transport is more costly since the whole plant must be carried to the retting water. In experiments made in Ceylon, however, it was found that the fibre could be stripped from the stem in the fields and it was then only necessary to convey the strips from the field for retting, so that transport was not so costly and there was a considerable reduction in the tank space necessary for retting. The method of stripping, as described in *The Planter* (November 22, 1922, page 372) is as follows:

"An effective method of stripping is to have about six pegs of hard wood fitted tightly into a good beam, say 3 ft. long on uprights of about 4 ft. in order to allow it to be fixed firmly in the ground. The method of stripping the fibre is to give the butt-end of the stalk three or four sharp taps until the fibre at the butt-end is freed from the stick, the ends being gathered in the hands; placing the fibre round the peg and pulling, when the whole of the fibre will strip from the stick. It is important

not to harvest more fibre than can be stripped on the day of cutting, otherwise the material becomes dry and it is then extremely difficult to separate the fibre from the stick. It would appear that the best time for harvesting is after rain, as the fibre comes away more easily from the stick than it does during a dry period. The retting tanks should be near a stream to facilitate the washing of the fibre after retting. Retting takes from eight to ten days. The material should be inspected on the eighth day and removed from the tank if sufficiently retted, but if not, left for another day or so until the process is complete. The cultivator is warned of the danger of over-retting, which causes the fibre to be weak and brittle. A recent report by a London broker on one sample of fibre submitted indicates this danger. The broker in question stated '. . . but part rather weak caused probably by being over-retted.' The fibre while in the tank is kept submerged in the water. This is easily done by placing heavy jungle timber over the fibre. The fibre, after being removed from the tank, is thoroughly washed in running water, if possible, and care taken to see that all foreign matter is removed during the process of washing. The next operation is sun-drying, after which the fibre is combed and baled, when it is ready for shipment. It is not essential to comb the material but it is to be recommended as a very much higher price is obtained."

With jute, the whole stem of the plant is retted. In view of the bulk of the plant and the cost of transporting it to the retting water, it seems surprising that no efforts have been made to obtain an easy cheap way of removing the bark with the fibre from the stems before retting, since the great proportion of the whole stem is a waste material which takes up valuable space in the water. It may be that the cost of stripping would be higher than that at present incurred in carrying the jute to the retting water, and that consequently the cost would be uneconomic. Possibly stripping the bark damages the fibre but this could no doubt be overcome. Experiments with jute have shown that near nodes, lenticels and places of injury the breaking-down of the tissues is slower than in other parts, and it is important that any method of stripping the stems before retting should not injure the fibre. For the same reason branching of the stems is undesirable since it helps to prevent uniform retting. Whether it is possible to strip the stems before retting or not, in view of the weight of the leaves it would seem worth while removing them before carting the stems to the retting ponds, since in the case of roselle, for example, the leaves weigh about 20 per cent. of the plant, and there is no point in incurring extra cartage charges on useless material. In any case, the leaves are much more suitable for fertiliser.

Information regarding the cost of growing roselle is scanty. In the Malacca Peninsula the cost of producing 1,000 kg. of hand-prepared fibre, based on a yield of 1,200 to 2,000 kg. of fibre per

hectare, was estimated to be 1,448 francs. Freight to London was 792 francs per metric ton, and since the fibre realised 4,800 francs per metric ton, the net profit was 2,520 francs per ton. To harvest 100 hectares of roselle and to extract the fibre by hand, 100 working days are necessary, the labour employed daily being 15 men and 164 women for an eight-hour day.

Other Species of Hibiscus.—Among other species of *Hibiscus* which have been suggested as substitutes for jute may be mentioned *H. quinquelobus*, *H. lunarifolius*, and *H. esculentus*.

Hibiscus quinquelobus.—The plant grows in Sierra Leone, and is often known as West African jute. During the year 1904-5, when there was a temporary shortage of Indian jute, small quantities of the fibre were exported to this country. When supplies of jute became normal, however, the demand ceased. It seemed that although the fibre is suitable for spinning with jute, spinners preferred to use jute when it was available at a reasonable price.

In French Guinea, where the plant is known as "rouma," the natives consider the fibre superior to *H. cannabinus* and to sisal, and neglect the cultivation of *H. cannabinus*, growing *H. quinquelobus* in its place. The fibre is said to be suitable for cord, thread, sacks and upholstery fabrics. Industrial trials made in France in 1920 were said to have been satisfactory. In French Guinea the plant is not cultivated and natural stands of the plant are used. It reproduces by rhizomes and after cutting puts up vigorous shoots from the root. The natives use these shoots for fibre which they obtain by retting.

Hibiscus lunarifolius.—This is known as "Ramma" in the northern Provinces of Nigeria. Samples received by the Imperial Institute in 1910 were reported on favourably by the trade and it was stated that the fibre would be readily saleable as a substitute for jute. The fibre was at one time exported in large quantities from the Northern Provinces.

Hibiscus esculentus.—This occurs in various countries and yields a fibre which is readily extracted and of good quality. The plant is said to be easily cultivated, and to thrive on poor soils such as drained marsh land, old river beds, old rice fields, etc. Successful trials were made in the Argentine with the plant in 1939 and it was stated to give a good yield of a coarse fibre.

As regards the cost of machinery for spinning Hibiscus fibre, the Imperial Institute had occasion to make inquiries on this question in 1941. One firm consulted estimated that plant to treat the fibre from the raw state and make it into yarn would cost about £20,000 f.o.b. British port. The plant, which has the minimum economic capacity, would have an output of about 600 lb. of yarn per hour. For weaving the yarn into bags, the smallest power-driven weaving plant, consisting of six looms, each 37 in. r.s., suitable for making plain woven cloth 30 in. wide, together with a single-ended dry beaming machine for filling the loom yarn

beams, an overhead sack sewing machine and a hemming machine, was estimated to cost about £1,200 f.o.b. British port. Such a weaving plant was stated to be suitable for the manufacture of bags for the transport of coarse materials, but the manufacturers informed the Imperial Institute that for bags which were to contain floury material, a more elaborate preparation of the cloth, including sizing and calendering, would be necessary. As regards output, these six looms could probably produce enough cloth to make 3,400 bags in a 48-hour working week.

Another firm consulted was able to offer a hand-loom, suitable for coco-matting, rugs, coal bags, etc., which was constructed entirely of steel, at prices between £23 to £27 according to the width of the loom.

The chief expense, therefore, is in the spinning of the yarn. In most countries, however, the various fibres are spun into yarns by the natives for fishing nets, twines, etc., and if this spinning could be increased and the yarn sent to the looms for bag manufacture, it should be possible to supply some of the demands for bags by local manufacture without the expenditure of too much capital. When there is a surplus of labour available, the spinning of the yarn could form a useful part-time occupation, in the same way as the spinning of coir yarn in Ceylon and India.

On the other hand, however, according to one firm of jute machinery makers consulted by the Imperial Institute, for economic production it is generally considered that a preparing, spinning, winding, weaving and finishing plant should consist of not less than 100 looms, and on to-day's figures the cost of such a plant would be in the neighbourhood of £150,000. This opinion is based on experience of commercial undertakings in open markets, and may not necessarily apply, however, where there is a closed market locally and where cheap labour and power are available.

The same firm has informed the Imperial Institute that *Urena lobata*, *Hibiscus cannabinus* and *H. sabdariffa* can all be worked on what is ordinarily styled jute machinery, and that although adjustments have to be made to suit conditions there is no question of material modifications. Plant for working all three fibres has been supplied by the firm in the past.

Coir.—Coir fibre obtained from the fibrous shell of the coconut, was at one time used in French Indo-China for bag-making and the bags were stated to be much cheaper than imported jute bags. According to trade reports, coir yarn is at present imported into the Union of South Africa from Ceylon for the manufacture of bags. Although coir is coarser than jute, its weaving properties are good. The only two sources of supply of the yarn on a commercial scale, however, are Ceylon and India, where the spinning of the yarn is done on cottage-industry lines. Just before the war France was endeavouring to import American machinery for the manufacture of bags from coir yarn.

Caroa Fibre.—This fibre is obtained from the leaves of *Neoglaziovia variegata.* and in recent years it has been used in Brazil as a substitute for jute. It is spun on machines used for spinning cotton and jute. The plant, however, grows wild and no attempts have so far been made to cultivate it or obtain improved strains. In view of the many other fibre plants which could be grown in the British Empire there would seem no point in commencing production of Caroa.

Sida rhombifolia.—Various species of *Sida* yield fibres which are very similar in chemical composition and behaviour to jute. In fineness Sida is equal to jute, but is stated to be more supple. A sample of *Sida rhombifolia* examined at the Imperial Institute from India in 1913 was valued at 20 per cent. above "first marks" Calcutta jute. The interior of the stem of Sida, however, is soft instead of hard and woody, and consequently the extraction of the fibre is rather difficult, and the yield per acre is lower than that obtained from jute. If a suitable method of extracting the fibre from the stem could be devised the fibre might have possibilities.

Other Fibres.—Many other fibres such as *Honckenya ficifolia*, various species of *Triumfetta*, ramie, Sunn Hemp, etc., have been suggested as jute substitutes, but since in some cases the fibre is difficult to extract in a marketable form by the usual methods, or the fibres have not the strength and flexibility of some of those already mentioned, it is not proposed to deal with them here. Various species of *Sansevieria*, for example, which occur in many Empire countries, yield a promising fibre which can be spun on jute machinery. Unfortunately, however, they do not lend themselves well to cultivation.

Conclusions

It should be possible to grow jute or one of its substitutes in the Colonial Empire. If the fibres can be grown where large quantities of food crops are also grown the cultivation of the fibres might form a useful secondary industry and the bags made from them would ensure independence of outside sources of supplies of bags. Nigeria, for example, normally imports annually about 6,000,000 to 8,000,000 bags which amount in value to well over £250,000. A local bag manufacturing industry would, therefore, save the expenditure of this money overseas and ensure the supply of bags for food crops. The aim would be, presumably, not to compete with jute in the world's markets, but to meet a more or less local demand for bags. In view of the consideration which is being given to the increased cultivation of rice in the Empire, it might be worth while investigating whether jute could also be grown on the same areas, in rotation with rice, as is done in India. First of all, however, it would be necessary to make trial cultivation of the fibres in order to see what quality of fibre is produced in a particular area and whether it can be spun and woven suitably by machinery.

It must be established, too, that water will be available for retting the fibre. Probably cultivation on plantation lines would be more desirable, but in view of the fact that jute and *Urena lobata* are both grown by native cultivators on small areas it should not be essential, provided a steady supply of more or less uniform quality fibre can be assured. Which method is adopted must depend to a large extent on the local economy, and the cost of production under both systems. Plantation production favours the use of machinery for harvesting, retting or decortication, and ensures that seed is pure and that crossing of the plants in the case of Hibiscus, for example, is prevented as far as possible. It also favours the production of a uniform fibre, which is most important, whether the fibre is to be exported to this country or to be manufactured into bags locally. By proper training and supervision of native labour, however, it should be possible to ensure proper preparation and grading of fibre grown under native cultivation, as is done with *Urena lobata* in the Belgian Congo, or with piassava fibre in Sierra Leone.

In some countries where a local bag-manufacturing industry has been set up, the industry has been aided by a subsidy in some form or another. Such a subsidy is possibly necessary until the industry is able to stand on its own feet in order to guarantee a market for the bags in competition with imported jute bags. If such a subsidy is to be a permanent feature, however, then it may be questionable whether the manufacture of bags locally is desirable, unless strategic or other reasons outweigh the economic factors.

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NOTES

Oil of Tetracarpidium conophorum.—Considerable attention has recently been given to the production of drying oils for the paint and varnish trade within the British Empire, and among those which have come into prominence is this oil, which is frequently alluded to as conophor oil. It is also known by the native names of "Awusa" and N'gart.

Tetracarpidium conophorum Hutch and J. M. Batz, previously called *Plukenetia conophora* M. Arg., N.O. Euphorbiaceæ, is a woody vine which occurs in tropical West Africa. In some countries, i.e. Sierra Leone, it is cultivated to some extent in recently cleared land. It starts to bear fruit in the second year. The fruit is from 2½ to 3 in. long and 1 to 1½ in. broad. In each of its four compartments is an almost spherical seed, which is composed of a thin, very hard, black shell, enclosing a white oily kernel. A sample of the fruits from the Belgian Congo gave the following figures:

FRUITS		
Fibrous pericarp	*per cent.*	44·5
Seed	,,	55·5
Average weight of a fruit	*grams*	48·5
SEEDS		
Kernel	*per cent.*	62·7
Shell	,,	37·3
Average weight of a seed	*grams*	6·7
KERNELS		
Average weight	*grams*	4·2

The seeds are eaten by the natives and have a bitter taste reminiscent of kola nuts.

The kernels contain from 48 to 60 per cent. of a golden-yellow oil, which has a taste and odour resembling those of linseed oil. Trials have shown the kernels can be safely fed to animals. The oilcake left after the removal of the oil by expression or extraction contains over 45 per cent. of proteins, and is used by the natives for edible purposes.

The analytical figures of the oil are:

Specific gravity at 15·5° C.		0·936–0·939
Refractive Index at 15° C.		1·4835–1·4870
Saponification value		190–195·4
Iodine value (Wijs)	*per cent.*	198–204
Unsaponifiable matter	*per cent.*	0·2–0·6
Solidifying point of fatty acids		24–25° C.
Hexabromides	*per cent.*	47·7

The composition of the fatty acids has been shown by Gunstone, Hilditch and Riley to be: saturated acids 13, oleic acid 10-11, linoleic acid 10-12, and linolenic acid 64-68 per cent.

As its analytical figures indicate, this oil belongs to the "drying oil" class of vegetable fatty oils and in this respect resembles linseed oil. When spread out in a thin film the oil dries to a clear hard film at room temperature in four days, and when kept at 50° C. in 18 hours. A varnish prepared by heating the oil at 180° C. with 3 per cent. of a lead-manganese drier (2 : 1) also dried in 18 hours. When heated alone at 300° C. the oil gelatinises within 6 hours, or at 250° C. after 35 hours.

Many years ago it was suggested that this oil, if it could be obtained in commercial quantities, might be used in the manufacture of paints, but only recently have serious attempts been made to exploit this oil for the above-mentioned purpose. This investigation has been initiated by the Colonial Products Research Council. It has been found in the course of this work that the seeds do not travel well, as owing to the presence of an enzyme the oil is readily hydrolysed during the storage or transport of the seeds. It has been shown that if the seeds are heated to 100° C. as soon as practicable after collection, they will keep in good condition and it is possible to obtain from them an oil of satisfactorily low acidity and of good quality. This investigation has confirmed the opinion previously expressed that the oil might prove to be a substitute for linseed oil. In this connection the following statement is made in the Fourth Annual Report (1946-47) of the Colonial Products Research Council:

> "It is hoped that the larger quantity of kernels (1 cwt.) which Nigeria have promised to supply, may be available at an early date when a thorough technical trial may be made with it. In the meantime, a small quantity has been sent to the Paint Research Department of the L.M.S. Railway. It must be emphasised that the possibility of the development of this linseed oil substitute depends (*a*) on whether the oil responds satisfactorily to the tests of the paint experts, (*b*) on the kernels being treated immediately after collection in the manner necessary to give the lowest free acid content with a reasonably good colour of the oil, and *above all*, (*c*) on the problem being envisaged in terms of an output of at least 10,000 tons of oil per year (or 20 to 25 thousand tons of kernels). The spasmodic production of a few tons or hundreds of tons of a drying oil is of no permanent interest to the paint and varnish industry."

A paper giving an account of this investigation under the auspices of the Colonial Products Research Council has recently been published by Gunstone, Hilditch and Riley.

Information is not available regarding the yield of seed per vine or per acre. Hitherto no cultivation has been undertaken on a plantation scale. Therefore if the production of this oil on the

scale mentioned above is decided upon, considerable preliminary work may be necessary to determine the best methods of large-scale cultivation.

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G. T. B.

Mastic.—Mastic (Mastiche, Mastix) is an oleo-resin obtained from *Pistacia lentiscus*, a small tree occurring in Southern Europe and North Africa, the chief commercial source of supply being the island of Chios, where collection of the resin has been carried on from ancient times. Small amounts of resin are obtained from other species of *Pistacia* in India and Turkey, but these are all used locally and the only species which is tapped commercially for export is *P. lentiscus*.

The tapping areas in Chios are largely confined to the northern part of the island, where the trees abound at altitudes of from 300 to 1,000 ft. Tapping is carried out during the latter part of the summer, the dry season, by making shallow incisions in the bark of the bole and larger branches. The resin is secreted from ducts situated very near the surface and a slight wound only is sufficient to cause flow. The mastic exudes in drops or tears and is collected singly or allowed to coagulate on the wound. The tears only are exported.

Some of the resin may fall to the ground and this, being somewhat contaminated by the soil, is of lower quality than that adhering to the bark. Contamination is reduced to some extent, either by the damping and hard ramming of the earth at the foot of the tree, or, preferably, by placing flagstones to receive the resin.

The annual yield of mastic is about 12 lb. per tree, but after the fourth year the yield and quality of the resin decrease to such an extent that further collection is not remunerative.

In commerce, mastic is met with in the form of small, pale yellow, brittle tears, transparent when fresh and having a faint balsamic odour. It consists mainly of resin acids (five of which have been isolated), amounting to 42·5 per cent. of the oleo-resin, and resenes (two in number), amounting to 50 per cent. It also contains about 2 per cent. of volatile oil, the chief constituent of which is d-pinene. When masticated, the oleo-resin softens in the

mouth, unlike sandarac, which it somewhat resembles in other respects.

Mastic is marketed in the United Kingdom in four grades; the resin of the first two, from their appearance, would seem to be washed, whilst that of the remaining two grades have the natural dust on the tears.

Pre-war and present prices of the different grades per lb. c.i.f. London, in 1 cwt. cases, are as follows:

		1938	1947 (December).
Grade No. 1.	Fine bold white .	2/8	15/-
Grade No. 2.	Medium bold white	2/6	14/6
Grade No. 3.	Bold yellow . .	2/4	14/-
Grade No. 4.	Medium yellow .	2/2	13/6

Even pre-war mastic was a comparatively expensive resin, chiefly employed in the manufacture of high-grade, very pale-coloured varnishes, for the protection of oil paintings. It is also used for a number of pharmaceutical purposes and in dentistry (for temporary stopping of teeth), and when cheap enough for cellulose lacquers.

H. T. I.

Carnauba Wax.—Owing to the high price now prevailing for carnauba wax, the possibility of its production in the British Empire has recently been under review. In this connection the following information will be of interest. The uses of this wax are many, but the largest quantities are absorbed in the manufacture of polishes, floor waxes, and carbon paper.

Source.—The wax is obtained from a palm of the genus *Copernicia*. Some authorities state that there are two closely related species: *C. caranda*, which gives no wax, and *C. cerifera*, which does produce wax (1, 8). They both occur chiefly in Brazil but the former occurs also in Bolivia, Argentina, Paraguay and in the Matto Grosso and Amazonas regions of Brazil. The latter is confined mainly to N.E. Brazil. The tree reaches a height of 12-15 metres (10) and begins to produce wax at 10 years, the maximum is reached at about 50 years (11).

Habitat, Climate and Soil.—The major producing area, i.e. N.E. Brazil, lies within the area 0-15° S. and 35-50° W. This region has long dry seasons without rain followed by wet seasons. It is stated that the palm occurs where the winter rain is only 400-600 mm., but also in places where it exceeds 1,200 mm. (4, 10), but opinions differ as to the effect of the wet season on wax production; although most agree that the palm is very resistant to temporary inundations, some state that winter flooding is necessary for a high yield of wax (5, 6); others state that it is unimportant (4).

C. cerifera is essentially an inland plant growing on the level

ground and barren plains along rivers, on the shores of lakes, but also to some extent in bays of coastal regions (3). It is wild and occurs in abundance in this semi-arid region of the N.E.

The soils are deep, alluvial soils or sandy beds of rivers where the soil is deep and without stones, also in sandy places near the coast (4). The depth of the soil is important since the palm has very long roots which tap deep water and supply the plant during the summer droughts.

Harvesting.—Cutting is carried out during the dry summer season when the wax is produced to prevent excessive transpiration from the leaves. The cutting time may be shortened in wet years, e.g. September-December, but may be prolonged in extra dry years, e.g. from September to February or March. During this time leaves are removed from the trees twice or sometimes thrice, but rarely more often (6). About 25 per cent. more wax may be obtained in extra dry years (4).

Preparation.—The leaves after collection are dried in the sun for 3 to 5 days (8). When dry, they are trenched, threshed and beaten. In the first operation the leaves are slashed against a row of 8 or 10 iron teeth, fitted in a block 6 in. wide, whereby the ribs are split apart and the webs opened up. Threshing consists of further ripping the leaves when the wax loosens. Finally the leaves are beaten in bunches of from two to four whereby the bulk of the wax is separated. The loosened wax is melted in open iron pots, in some cases water being added. The molten wax is strained through cotton or burlap either by hand or by pressure in a screw-press, and collected in containers. When solid, the bottom layer of impurities and wax is removed and the wax recovered by further melting and straining. Of recent years several mechanical extractors have been invented, but information is not available regarding the adoption of any of them.

Yield. One authority states (5) that about eight leaves are removed from a palm at each cutting, and usually the palms are subjected to two cuttings a month or approximately 100 leaves in a season. Disagreement has been recorded (10) with these figures and it has been stated emphatically that 10-15 leaves per tree per year only are cut and these are cut at three different times.

Most authorities agree that the average yield is about 6-7 g. per leaf or 15 kg. of wax from 2,000-3,800 leaves, but the yield varies considerably with the season (2, 5). For the wet summer season of 1921, 202·9 leaves were needed to give 1 kg. of wax. In a normal season, e.g. 1923, 147·0 leaves were required, but in a dry season, e.g. 1931, only 124·3 leaves were needed.

Empire Cultivation.—It is stated by Howes (5) that *C. cerifera* has been grown in British Guiana, East Indies, East Africa, Ceylon and Malaya, but no record is given of the progress these palms made. The palms planted in Ceylon 30 years ago flourished and were used in several ways, but they produced no wax (8).

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I.C.S.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

DEVELOPING VILLAGE INDIA. Compiled by M. S. Randhawa, M.Sc., F.N.I., I.C.S., F.I.A.Sc., F.N.A. Edited by U. N. Chatterjee, D.Phil., D.Sc., F.N.A.Sc. Special Number of *Indian Farming*, 1946. Pp. xvi + 291, 10 × 7½. (New Delhi: Imperial Council of Agricultural Research, 1946.)

Indian agriculture presents many problems, great and grave. The size of the country, the pressure of population, the maintenance and improvement of soil fertility, the training of the peasant-cultivator—all these are different aspects of the same complex picture.

Fortunately, the central organising body is alert to the opportunities before it, and on its activities much of the success of present and future policy will depend. The Imperial Council of Agricultural Research, with headquarters at New Delhi, takes the broadest possible view of the scope of research and is well equipped to carry out central policy. The Council issues a monthly journal in English—shortly to appear in Hindi and Urdu as well—entitled *Indian Farming*, which gives wise counsel to Indian farmers seeking scientific solutions for their problems. The Council Secretary, M. S. Randhawa, has compiled "Developing Village India" as a special number of *Indian Farming*; it is beautifully illustrated, conveys a great deal of useful information on agricultural "planning" for India, and has obviously been a labour of love to Mr. Randhawa and his collaborators.

We start, as always, with the village as the unit. One of the fundamental problems, interesting and vital, is the question of soil fertility. Some of the richer soils to the north of the Ganges valley are periodically flooded during the rains and receive rich silt from the Himalayas; they may be good for two or even sometimes three crops in the year without exhaustion. But other less fortunate areas depend on fertilisers, natural or artificial, and here steps are being taken to improve fertility. The utilisation of village

wastes is well described by C. N. Acharya. In addition, of course, irrigation by new, up-to-date and whole-scale methods has done much to bring former deserts under the plough.

And here, again, a kindred problem arises. Although mechanisation is making great strides it is difficult (*a*) in small holdings, (*b*) in wet lands. The plough is, therefore, mostly bullock-drawn and the depth of ploughing must vary with the type of plough and with the strength of the animal. An interesting article (by Sir Datar Singh) describes the natural competition between the draught-cattle and the milch-cattle for the not unlimited supplies of fodder available. Mechanisation (D. R. Sethi) would liberate fodder for milk-production and would facilitate deeper ploughing; to say nothing of increased opportunities for improved transport to urban centres where better prices are often obtainable.

Sir Pheroze Kharegat is an authority on the question of village populations as consumers as well as producers; the prevalence of deficiency disease; and the vast subject of optimum nutrition based entirely on foodstuffs locally produced. Variety of diet is important; but equal or greater importance is attached to an increase of milk and milk products. An interesting table compares the items, and weights, required for a balanced diet with the quantities available. Whilst 18·5 oz. of cereals are available per adult per diem and only 16 oz. are really required—the rest being exported chiefly in the form of wheat or flour—every other item shows a deficiency, with milk in greatest defect. An interesting and suggestive plate compares unproductive with productive expenditure by the Indian peasant in "Snakes and Ladders" form.

Some of the most valuable successes obtained by village organisations are described in the earlier chapters of the volume. The Panchayatghar (M. S. Randhawa) corresponds to our Village Institute, and indeed goes somewhat further, combining library with local museum, co-operative store, physical culture and dispensary. Co-operative Societies are given their proper place. F. L. Brayne, a well-known expert, describes what the ex-service Indian can and should be doing to apply his practical experience and training to the cause of village uplift and social progress.

Finally, two able articles are contributed by D. D. Sabnis and V. R. Bhatt—the former on "Rural Broadcasting in India," with its immense potentialities for education and cultural advancement; the latter on "Films for the Villages." The Information and Arts Department of the Government of India have done good work here, producing "over 160 documentaries some of which have received international recognition." The titles of a selection of the best of these films are quoted in this article. It is satisfactory to note that many of them have received extensive and well-earned publicity through the Empire Film Library of this Institute and through the weekly film-programmes of the Institute's Cinema.

H. A. F. L.

THE METHODS OF CELLULOSE CHEMISTRY including Methods for the Investigation of Substances associated with Cellulose in Plant Tissues. By C. Dorée, M.A. (Oxon.), D.Sc. (Lond.), F.R.I.C. Second Edition, revised. Pp. xii + 543, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Chapman and Hall, Ltd., 1947.) Price 42*s*.

This work is a much revised and supplemented edition of the original, which was published in 1933 (reviewed in this BULLETIN, 1933, **31**, 126).

The subject matter is divided into three parts together with an appendix which gives useful tables relevant to the subject. The first part of the book deals with normal, oxy- and hydro-cellulose. The chain molecular theory of the structure of cellulose is emphasised by the description, with many practical details, of the method of end-group estimation and other methods of determining chain length, as well as by the chapter on degradation products of cellulose. It concludes with an account of the investigation of damage in cotton and linen fabrics and fibres and includes plates showing the effects of damage on individual fibres.

The second part deals with the synthetic derivatives of cellulose including the properties and examination of viscose. Two chapters have been added to the material of the first edition, one on the general properties of cellulose esters and another on cellulose ethers.

The third part, being an account of the compound celluloses, consists mainly of methods for the examination of plant tissues, the estimation of cellulose and lignin and their degradation products, and the analysis of wood and wood pulp. The subject of wood pulp and pulp processes is dealt with very fully. The book is concluded with a chapter on pectic substances and their composition.

The new edition of this important book is to be recommended to students and research workers alike, particularly on account of the wealth of practical detail and numerous references given in the text.

N. S. C.

MODERN CEREAL CHEMISTRY. By D. W. Kent-Jones, Ph.D., B.Sc., F.R.I.C., and A. J. Amos, Ph.D., B.Sc., F.R.I.C. Fourth Edition. Pp. vii + 651, 10×6. (Liverpool: The Northern Publishing Co., Ltd., 1947.) Price 50*s*.

The third edition of this work, published in 1939, was reviewed in this BULLETIN (1939, **37**, 603). The advances in cereal chemistry during the ensuing seven years have been so numerous as to necessitate complete rewriting of the existing chapters and the introduction of two new ones for the fourth edition.

Written throughout in the characteristic style of the authors, it should be readily understood by all who are concerned with cereals, processed or unprocessed, as well as the cereal chemist. The chapter on "Cereals other than Wheat" has now been sub-

divided into "Barley" and "Rye, Oats, Maize, Soya and Potato," this latter chapter giving more complete information than previously.

The laboratory tests and analytical methods are fully detailed, giving the analyst first-hand information, thus avoiding the necessity of consulting original literature. The chapter on general analysis covers practically every estimation usually required, while the additional chapter on vitamin assay is very welcome and fully describes modern methods of the assay of the more important vitamins found in cereals.

The bibliography and indexing are extremely well done, and the binding, printing and diagrams are excellent. This latest edition of such a useful book should prove a great asset to all "cereal" workers.

R. W. P.

A NEW DEAL FOR THE COLONIES. British Survey, Vol. VIII, No. 6, May, 1947. Pp. 16, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: British Society for International Understanding, 1947.) Price 6*d*.

The British Society for International Understanding is to be congratulated on this, the most recent of its British Commonwealth Surveys. The series is partly regional—the Far East, East Africa, West Africa, Southern Africa, Southern Asia—and partly national, dealing with individual Dominions or Colonies. To the "popular" series, simply told, illustrated, and particularly valued by the school teacher, belongs this new issue *A New Deal for the Colonies*.

During the earlier years of the Second British Empire—and particularly during the nineteenth century—the temperate zone Colonies naturally attracted more attention and more immigration than the tropical Colonies. In 1867 Canada became a Dominion on the strength of the Durham Report; and during the early years of the twentieth century the other Dominions came into being. With the Statute of Westminster the New Deal for the Dominions is consummated.

The New Deal for the Colonies dates, according to this Survey, from 1929, when the first Colonial Development Act was passed by the British Parliament, establishing a Colonial Development Fund by means of an annual Parliamentary grant of £1,000,000. The foundation of the policy of Trusteeship was thus laid. But the 1929 Act did not go far enough. For one thing the grant was inadequate. For another, its scope was chiefly economic and did not embrace either education or administration.

The idea of Trusteeship gained clarity and depth of purpose from the publication in 1938 of Lord Hailey's *African Survey*. The result, in the Colonial Development and Welfare Act of 1940, was striking. The annual Parliamentary grant was raised from £1 to £$5\frac{1}{2}$ millions; the field of the services which could be rendered to the Colonies was immensely widened by the addition of the word "Welfare"; and finally the idea of Trusteeship was proclaimed

as the recognised attitude of the British Government towards its Colonial Empire.

Examples are given of actual and practical assistance afforded to the Colonies in terms of the 1940 Act. But even this was not enough. In 1945 the funds to be spent on Colonial Development and Welfare were increased by the Act of that year to £120 millions to be spread over the ten years 1946-1956. Since 1945, over thirty ten-year plans have been drafted and by March 1947 ten of these had been approved. The mechanism of the Fund is explained and practical examples of " plans " are quoted.

It is a stimulating story, that told in this new British Survey, ending with the Tanganyika groundnut scheme of 1946. Two points are worth stressing—the very great part played by Lord Hailey in the effectual prosecution of the New Deal; and the great importance of the African Colonies in the needs of the Colonial Empire and in the formulation of the policy to meet these needs. Perhaps a further Survey will bring out these points in detail. A further Survey on the subject of the Colonial Empire is particularly necessary in the not too distant future, if only to draw attention to that latest phase of the New Deal, the development of the self-governing Colony. As Canada was for many years the pattern of all subsequent Dominions, so Southern Rhodesia has been for many years the pattern of the self-governing Colony. Ceylon will attain Dominion status ere long—Malta and Cyprus, Malaya and other Colonies are progressing on the upward path towards full nationhood. Colonial Trusteeship, as Lord Hailey has more than once remarked, is expanding into Commonwealth Partnership.

H. A. F. L.

DDT AND THE INSECT PROBLEM. By James C. Leary, William I. Fishbein and Lawrence C. Salter. Pp. vii + 176, $8\frac{1}{4} \times 5\frac{3}{4}$. (New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1946.) Price 12*s*. 6*d*.

This publication is the story of a new insecticide, its history, possibilities and limitations, rather than a textbook designed to summarise the scientific data collected during the development of DDT. It is written throughout in a style suitable for the lay rather than the scientific mind and when accepted as such can undoubtedly fulfil a very useful purpose. It is disappointing to note, however, that the book has been based, almost entirely, on information available in United States literature and that little reference is made to the very important work carried out in this country.

The text is divided into eight sections, namely, an introduction to the subject; insects and insecticides; chemistry and pharmacology of DDT; the application of DDT; its use during the war; its use for man's health and comfort; its use in agriculture; and a final chapter on forest, shade and fruit tree insects. The book

is written in a free style and the text throughout is easy to follow. There is a good index and a useful bibliography.

In its early days DDT received a considerable amount of undesirable publicity which gave the impression that it would be the universal insecticide of the future. It is therefore pleasing to note that throughout this book the authors have drawn the reader's attention to the fact that although DDT has now many accepted uses and further possibilities, it also has many limitations and must, therefore, take its place in the general scheme of insecticide application.

H. E. C.

BIBLIOGRAPHY OF THE TECHNICAL LITERATURE ON SILK. By F. O. Howitt, Ph.D., F.R.I.C., F.T.I. Pp. xxiv + 248, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Hutchinson & Co., Ltd., 1946.) Price 21*s*.

This work represents the results of some ten years' study of the literature of silk. When the author became Head of the Silk Section of the British Cotton Industry Research Association in 1936, he found the need for a comprehensive and critical review of the existing published information which, as is usually the case, is largely contained in articles scattered over monthly periodicals in a number of languages. His primary intention was to provide a working guide to the literature for the benefit of himself and his immediate colleagues. Fortunately, however, the Council of his Association decided to sponsor publication of the review in its present form.

To introduce the subject, a short account of the cultivation of silk is provided together with a glossary of silk terms. Thereafter the several chapters deal with the properties of raw silk; of sericin and degummed silk; and with the various processes in silk manufacture. An index of patents is added to the usual indexes. In all, more than two thousand publications have received consideration.

It gives the Imperial Institute particular pleasure to welcome this bibliography as the author, Dr. F. O. Howitt, is a member of its Consultative Committee on Silk and of this Committee's Technical Sub-Committee.

E. H. G. S.

STUDIES IN COLONIAL LEGISLATURES. Edited by Margery Perham. Vol. II. THE GOLD COAST LEGISLATIVE COUNCIL. By Martin Wight. Pp. 285, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: Faber & Faber, Ltd., 1947.) Price 12*s*. 6*d*.

Miss Margery Perham is to be congratulated on this second volume of *Studies in Colonial Legislatures* which she edits. The first volume of the series, entitled *The Development of the Legislative Council*, 1606-1945 (reviewed in this BULLETIN, 1946, **44**, 27), was also written by Mr. Martin Wight, who has shown himself just as capable of studying with a microscope the give and take of political

power on the stage of a single dependency, the Gold Coast, as he was with his telescope, surveying broadly the history of British Colonial Legislatures and their evolutionary forms.

Mr. Wight might have taken for his motto, in addressing himself to both tasks, "The facts, and no nonsense about them." That is his outstanding achievement—factual presentation—the facts so skilfully marshalled, so clearly and convincingly portrayed, that future generations will want little more to complete the picture up to the present date.

But of course the local conditions vary considerably as between peoples still in the early stages of political responsibility. The kaleidoscope changes from time to time—almost, one had said, from Governor to Governor. The principles on which British Colonial Governments are based are fundamentally the same, but their application to different peoples (especially to citizens varying ethnically and linguistically *inter se* within the same State) is bound to vary, and successive Governors naturally take different views as to the particular toe pinched by the administrative shoe. Some Governors will think that a shoe-horn will do the trick; others, the more conscientious perhaps, will try to remodel the shoe. Mr. Wight has brought out these differences of treatment and method in his account of recent Governors of the Gold Coast.

What are the broad principles at stake, fundamental to British democracy and to British colonial administration?—not very different from those which the Pilgrim Fathers carried to America and in defence of which their descendants seceded. At their very simplest, there are three:

(*a*) No taxation—and, since taxation is a legislative matter, no legislation—without popular representation.

(*b*) No citizen is above the law, not even the Governor; he may lay it down himself, by Ordinance, but he must himself obey it and must see that it is impartially administered.

(*c*) In the event of a dispute between State and Subject, the dispute must be settled by an entirely independent judicature.

Now, in their application to dependent races, it is obvious that principles (*b*) and (*c*) are easiest for the colonial citizen to understand and for the colonial administration to apply. It is principle (*a*) which causes most heart-searchings, and to which Mr. Wight quite correctly and fairly devotes the greater part of his attention.

Popular representation is in truth a most complex affair. It is difficult to deny that an official majority may have the interests of the citizen just as much at heart as the unofficial majority; or that the unofficial nominated majority will betray the same care for the citizen as the unofficial elected majority. But somehow it is not quite the same thing. The goal of British colonial administration, whatever it may have been in the past, is now certainly representation by election. The methods of election may vary, from those in which the influence of local chiefs is paramount, to

those which are more truly popular; and, again, from indirect to direct methods. The objective is the same—that both electors and elected shall acquire and develop that sense of responsibility which will put national before purely personal or sectional interests.

It will be realised at once how profound is the difference between French and British conceptions of colonial government. The French have always taken, and still take, a very realistic view of their colonial responsibilities, and according to this view "whate'er is best administered is best." That is the lamp which lights their path, and a very good lamp too. But they have forgotten the star. In what direction are they heading? What general principles are at stake? If efficiency is your sole criterion, may you not find yourself merely revolving on your own axis, chasing your own tail of inefficiency until the head whirls and migraine besets the body politic.

No, it just isn't good enough. In spite of all temptations to the contrary, one must keep in view the star of political responsibility and not be guided merely by the lamp of administrative efficiency. These are considerations which underlie most of the pages of Mr. Wight's book. He was happy in his choice of a dependency, the Gold Coast, which combines both Protectorate and Colony and thus comprises various forms of local self-government, and whose peoples are endowed with strong civic sense and are quick to realise the opportunities which political responsibilities afford. He has handled difficult political questions with sympathy and with fairness. Both editor and author are to be congratulated on the first two volumes of this interesting and instructive series. May subsequent volumes maintain the same high standard.

H. A. F. L.

Imperial Preference: Its Development and Effects. Compiled by R. S. Russell, M.A. Pp. 168, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Empire Economic Union, 1947.) Price 5*s*.

The Empire Economic Union, through its Research Secretary, Mr. Ronald S. Russell, has done a public service to both nation and Empire in compiling and publishing this volume on Imperial Preference. The facts of the case are clearly stated and the arguments skilfully marshalled.

Mr. Amery asks, in his Foreword, "What are we doing, what can we do, to maintain the unity and security of the Empire and to preserve, from internal disintegration or from external aggression, the greatest instrument of political and social progress the world has yet known?" It is no mere rhetorical question, but one which faces every citizen of the Commonwealth, particularly in these days when peace-time conditions seem to threaten the stability and cohesion of the Commonwealth even more than the two great wars which indeed established it more firmly than ever.

But peace-time threats are, perhaps, more serious than those of

war. Either World War might have brought about a collapse of Britain and disintegration of the Empire. The attacks of our friends are likely to be more insidious and more drawn-out than those of our enemies, if only because the methods of negotiation in modern conditions of international life are slower than those of warfare—slower, more deliberate, calling for equal skill and determination in defence of the cause for which we stand.

For indeed it is a magnificent cause—nothing less than the economic survival of millions of our own kith and kin overseas and of still greater millions of alien but friendly peoples for whom we have made ourselves (not always deliberately, but effectually none the less) responsible. The British Empire, like Topsy, "just growed." There were days up to a century ago when we fought to establish it. But those days are long over and the past century, apart from the South African and the first World War (with its mandatory consequences), has seen natural expansion by friendly methods. As Domination gave way to Protection and Protection to Trusteeship, so within the last decade the idea of Trusteeship is giving way to that of Partnership. Self-government on democratic lines is the British Commonwealth ideal and it is being steadily pursued.

Mr. Russell successfully establishes the importance of imperial preference, as a policy, to the economic cohesion and progress of the Commonwealth. He summarises the early history of the policy; shows how the United States, perhaps the keenest critics of imperial preferences, have applied it themselves in deliberate adoption of a policy which they repudiate whilst they copy; and finally demonstrates the great practical advantages to world trade arising from British imperial preference. More than that, he favours extensions of preference to countries outside the Commonwealth which have trade advantages to exchange with us, perhaps at lower rates of preference than those obtaining within the Commonwealth.

The important point, which the United States seem to forget, is that tariff barriers, however desirable socially or politically, are economically unsound. Any reduction of such barriers is desirable so long as national industries are not undermined. British policy in granting preferences to a wide number of Commonwealth countries is setting a good, not a bad, example; and Britain is, from this point of view, a pioneer of freer world trade in years still unborn.

H. A. F. L.

THE ANGLO-PALESTINE YEAR BOOK. Edited by F. J. Jacoby. (London: Anglo-Palestine Publications, Ltd.; Palestine: 105 Allenby Road, Tel-Aviv.)

The first edition of this year book was published in the early months of 1947. Its object is to provide a comprehensive reference book which will prove a reliable guide to business men and others desirous of obtaining up-to-date impartial information on Palestine.

Among the features of the first edition of this book is an account of this country's development since the inception of British administration. Information is given regarding the raw materials available, the agricultural and citrus industries, and the development of these and other industries. Particulars are included concerning the chief towns; building and housing; and transport and communications. Statistics are given relating to foreign trade together with details of the customs tariff.

This year book contains a mass of useful information and is thoroughly indexed and cross-indexed so that readers can readily find any particular item they may desire. It should prove of great value to those whose interests lie in Palestine.

A new edition for 1947-48 is in the press and should be available in February, 1948.

G. T. B.

THE BEE CRAFTSMAN. By H. J. Wadey. Fourth Edition. Pp. 117, $7\frac{1}{2} \times 5$. (Kent: A. G. Smith, Bracken Dene, Manor Way, Petts Wood, 1947.) Price 4*s*. 6*d*.

This little book has been written primarily to assist beginners with the problems encountered in keeping a small apiary. The author, who is the present editor of *Bee Craft*, has had over twenty years' experience as a bee-keeper and is therefore well qualified to write on this subject.

The work is divided into four parts. Part I deals with the story of the colony, its inhabitants, the queen, drones and workers, and the way they co-operate to live together in harmony and to produce honey. Part II is devoted to more practical details of bee-keeping such as advice on the most suitable kinds of hives, the site and arrangement of the apiary. Instructions are given regarding the best way to handle bees and of feeding them. Swarming is described and methods given to prevent this phenomenon and to deal with it when it occurs. The management of the hive forms the theme of Part III when further help is offered in connection with swarming and its control. The removing of the honey cap and the extraction of honey and its processing are also dealt with in this part together with methods of forming new colonies and how to treat stray ones. The last part of the book includes sections devoted to sickness in the hive and diseases of the brood, methods of treatment being given.

The book is written in a very readable style and in non-technical language easily understood. It contains a lot of very helpful information which should prove of value not only to those just starting bee-keeping but also to those who have been engaged in this work for some years. It is however not to be regarded as a work of reference. Those who require such works should consult those mentioned in the bibliography included at the end of this book.

G. T. B.

OUTLINES OF PAINT TECHNOLOGY. By Noel Heaton, B.Sc., Hon. A.R.I.B.A. Third Edition, revised. Pp. xi + 448, 9 × 6. (London: Charles Griffin & Co., Ltd., 1947.) Price 32*s.*

The appearance of a new edition of this well-known work will be welcomed by all who are interested in the paint and varnish industry and particularly by students for whom it was primarily written. Within its pages is a wealth of information which is presented in a form free from an excess of technical detail, for which readers can, if they so desire, refer to the works of reference and original papers mentioned as foot-notes or in the bibliography given as an appendix.

Since 1940 when the previous edition was published a considerable amount of fresh knowledge has become available and much information regarding paint technology has been acquired through the investigational and research work that has been carried out in this intervening period. As a result it has been found necessary to re-write extensively parts of the book, in particular the chapters on Natural Resins and on Drying Oils while new chapters on Metallic and Luminous Pigments and Water Paints have been added.

The original arrangement of the contents has in general been maintained. The alterations and additions made all add improvements. The book is divided into three parts dealing respectively with pigments; oils, solvents and resins; and paints and varnishes. Pigments, as a rule, are grouped together under the different colours while oils and resins are considered under the heads of natural and synthetic. Paints and varnishes are dealt with in four chapters, one being devoted to each class of these products, namely varnishes and lacquers; oil paints; water paints; and cellulose ester and ether products. Five appendices together with name and subject indexes complete the volume.

This book, which includes 11 plates and 73 illustrations in the text, is clearly printed and the headings and sub-headings to sections stand out well so that reference to the contents is facilitated. This third edition maintains the high standard of previous ones and will, like its preceding ones, be of great value not only to students but to many others who are interested in paints and varnishes.

G. T. B.

THE PRINCIPLES AND PRACTICE OF WINE MAKING. By W. V. Cruess. Second Edition. Pp. xii + 476, 8 × 5½. (New York: The Avi Publishing Co., Inc., 1947.)

The first edition of this book was published in 1934. Since that date the progress made both in the technology of wine making and in the understanding of the principles involved has been so marked that it has been necessary to re-write completely most of the chapters and to add new ones when preparing this second edition.

The opening chapter deals with the different wines and the districts of the world in which they are made. It could with advantage have been condensed by the elimination of matter of small import. Three short chapters follow in which types of wine are described and their chemical composition given; the varieties of grape that occur in California are enumerated and recommendations made regarding the most suitable to cultivate in different districts of that state; and the preparation of yeast starters is described in view of the desirability of inoculating crushed grapes and juice with such organisms early in the season when very few yeast cells are present.

The greater portion of the book is devoted to the production of red and white wines, sherry, brandy, fruit wines and others of lesser importance. These chapters are supplemented with others describing the essential cellar operations and the methods of ageing wines. Attention is drawn to the liability of wines to suffer from many forms of deterioration, which are treated under the headings of non-bacterial defects and spoilage through micro-organisms. These are dealt with in some detail and methods given for prevention. Among the final chapters are two in which the utilisation of winery by-products is described and methods given for the laboratory examination of wines. Throughout the book special references to literature are included at the end of many of the chapters.

The book contains a mass of information which will be of value and interest to the makers of wines and to chemists and microbiologists. It must however be pointed out that attention is focused throughout the work to methods and conditions prevailing in California although reference is frequently made to practice in other wine-producing countries.

G. T. B.

Catalogue of Lewis's Medical, Scientific and Technical Lending Library. Supplement, 1944-1946. Pp. iv + 176, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Lewis's Library, 1947.) Price 5*s.* (to Subscribers 2*s.* 6*d.*).

All those who are studying for professions and those already qualified who desire to become acquainted with published work upon their particular subjects are conscious of the need of having access to a good library from which standard works can be borrowed. The need for borrowing has in these days been greatly enhanced by the difficulty of purchasing books owing to the limited editions, which are issued, and in the case of some foreign works, to the prevailing restrictions on importing printed matter from some countries.

Those who live in cities or large towns in this country have ready access to well-stocked libraries but those who have not such facilities welcome the opportunity of borrowing the books they

desire to study from such a library as Lewis's Medical, Scientific and Technical Lending Library.

This Library has for the benefit of its clientele recently issued a Supplement to their Catalogue in which are included the additions made to their books during the years 1944-1946. This Supplement will be of great use not only to the borrowers but also to those who want to consult a list of recent literature.

G. T. B.

Raising Livestock. By Walter H. Peters and George P. Deyoe. Pp. x + 519, $9\frac{1}{4} \times 6\frac{1}{2}$. (New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1946.) Price \$3.50 (17*s.* 6*d.*).

At the present time, when there is a serious shortage of beef, mutton and pork in many countries of the world, strenuous efforts are being undertaken to increase supplies by means of an intensified raising of livestock. The publication of this book is accordingly made at an opportune time, and although intended primarily for those of small experience, yet it contains information of value to those who have been engaged for a number of years in the business of raising livestock.

In this book the authors consider the whole question of raising livestock from the preliminary stage when initial decisions have to be made regarding the scale of the undertaking and the drawing-up of a programme up to the marketing of the livestock and in the case of animals used for human consumption, up to the preparing and processing of livestock products. The animals dealt with in the book include hogs, dairy, beef and dual-purpose cattle, sheep, goats, horses and mules. The selection of the best breeds, which forms the subject of the second chapter, is an essential of successful livestock raising and due emphasis is laid upon it, while in a subsequent chapter advice is proffered on breeding and methods of improving livestock described. Other portions of this book are devoted to the usual aspects of livestock raising such as their feeding, housing, care and handling, and maintenance in good health. In the last two chapters marketing is described and methods given for processing the products for human consumption.

The book is lucidly written and the subjects are dealt with in sufficient detail. It contains a mass of useful information and practical advice which should prove of value not only to the prospective farmer but also to those who already have the responsibility of raising livestock.

G. T. B.

Leguminous Forage Plants. By D. H. Robinson, Ph.D., B.Sc., N.D.A. Second Edition. Pp. vii + 119, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Edward Arnold & Co., 1947.) Price 7*s.* 6*d.*

This book, the first edition of which was published ten years ago, is written with the expressed object of facilitating the recogni-

tion of the more important leguminous plants grown on the farm, with particular reference to the British Isles. The author claims that there is a definite need for a book of this kind owing to the absence of any convenient work in the English language, which describes these plants sufficiently adequately to enable the inexperienced to recognise them.

The opening chapter describes the general characteristics of leguminous forage plants. In succeeding chapters these plants are considered in the various groups, such as the clovers, the medicks and other pasture plants. These are followed by two chapters on plants grown as field crops and pulse crops sometimes grown for fodder.

Each plant is described, both in the seedling and in the mature stage; its uses given and details of its chemical composition furnished. Every species is illustrated by drawings. The book is written in as simple a style as possible and a glossary is supplied to explain the botanical terms employed. It should prove of value to those for whom it is intended, mainly for students at agricultural colleges, but others of greater experience will no doubt find it of use.

G. T. B.

BOOKS RECEIVED FOR REVIEW

The Story of Wool. By William F. Leggett. Pp. vi + 304, $7\frac{1}{2} \times 5$. (Brooklyn, New York: The Chemical Publishing Co., Inc., 1947.) Price $5.00.

The Cooperage Handbook. By Fred Putnam Hankerson. Pp. vi + 182, $8\frac{1}{2} \times 5\frac{1}{2}$. (Brooklyn, New York: The Chemical Publishing Co., Inc., 1947.) Price $3.75.

Advances in Grassland Husbandry and Fodder Production. Second Symposium. Imperial Bureau of Pastures and Field Crops. Pp. 83, $9\frac{3}{4} \times 7\frac{1}{4}$. (Imperial Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, 1947.) Price 6*s*.

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The Use and Misuse of Shrubs and Trees as Fodder. Imperial Agricultural Bureaux Joint Publication No. 10. Pp. xxxv + 231, $9\frac{3}{4} \times 7\frac{1}{2}$. (Imperial Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, 1947.) Price 9*s*.

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IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY OF INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 38

(January to March 1947)

Compiled by MISS R. M. JOHNSON

With the collaboration of the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

General

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ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

The Cotton Aphid. By D. Isley. *Bull. No.* 462, *Arkansas Exp. Sta.*,

1946. (*Exp. Sta. Rec.*, 1946, **95**, No. 6, 834.) A cotton aphid outbreak can be controlled by dusting with calcium arsenate containing 3 per cent. nicotine.

Cuban Laurel Thrips Control on *Ficus benjamini*. By D. O. Wolfenbarger. *Fla. Ent.*, 1946, **28**, No. 4, 82-83. (*Exp. Sta. Rec.*, 1946, **95**, No. 6, 836.) Nicotine gives some control, but not so effective as some synthetic compounds.

Australian Nicotine Production. *Chem. and Drugg.*, 1947, **147**, No. 3494, 131. The production of this insecticide from *Nicotiana rustica* being encouraged in Australia.

Insecticide. U.S. Pat. No. 2,407,041. *Amer. Chem. Absts.*, 1947, **41**, No. 5, 1381. Consists of an aqueous dispersion of vegetable oil, phosphatides, arsenic and other toxicants, including nicotine sulphate.

Others

Toxicity of Nicotine, Nornicotine and Anabasine to Codling Moth Larvae. By E. H. Siegler and C. V. Bowen. *J. Econ. Ent.*, 1946, **39**, No. 5, 673-674. The most effective compound was nicotine.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

The Control of Psyllids and Flea Beetles on Potatoes. By W. A. Riedl and L. R. Harrison. *Bull. No.* 271, *Wyo. Agric. Exp. Sta.*, 1945. (*R. A.E.*, 1946, **34**, A, No. 12, 358-359.) 0.5 per cent. rotenone in sulphur gave excellent control of the adults of the flea beetle; also effective against the nymphs and adults of the psyllid.

The Mexican Bean Beetle. By B. B. Pepper. *Circ. No.* 495, *N. Jersey Agric. Exp. Sta.*, 1945. (*R. A.E.*, 1947, **35**, A, Pt. 1, 13.) Of the insecticides recommended derris or cube applied in sprays or dusts are considered the best.

Cattle Grubs or Heel Flies with Suggestions for their Control. By F. C. Bishopp, E. W. Laake, and R. W. Wells. *Frms'. Bull. No.* 1596, *U.S. Dep. Agric.* (*R. A.E.*, 1946, **34**, B, Pt. 12, 189.) Derris or cube in dusts and washes gives control of *Hypoderma lineatum* and *H. bovis*.

A Confirmatory Modification of the Test for Rotenone-Type Compounds. By M. A. Jones. *J. Assoc. Offic. Agric. Chem.*, 1946, **29**, 127-129. (*Amer. Chem. Absts.*, 1946, **40**, No. 22, 7488.)

Control of Cattle Ticks in Tropical Regions. By R. L. Squibb. *J. Animal Sci.*, 1946, **5**, 71-79. *Brit. Absts.*, 1946, B III, December, 267. Spray made by mixing DDT and rotenone (10 per cent. green crushed derris roots) very effective; more effective than DDT or rotenone alone, or than mixtures of these ingredients in other proportions.

The Action of Rotenone on Intestinal Infestations of Protozoa and Helmintha in the White Mouse. By E. Beltran, R. Larenas and F. Guerra. *Rev. Inst. Salubridad Enfermedad Trop.* (*Mexico*), 1946, **7**, 53-56. *Amer. Chem. Absts.*, 1946, **40**, No. 21, 6688.

The Action of Rotenone and Mexicaina on Experimental Trichomonas in White Mice. By F. Guerra. *Rev. Inst. Salubridad Enfermedad Trop.* (*Mexico*), 1946, **7**, 57-61. (*Amer. Chem. Absts.*, 1946, **40**, No. 21, 6688.)

Co-Solvent for Insecticides. U.S. Pat. No. 2,396,983. *Soap*, 1947, **23**, No. 1, 147. A method of solubilising rotenone or its extracts in petroleum oils for insecticidal use utilising a co-solvent consisting of secondary butyl phenols.

Derris

Experiments on the Control of the Bean Seed Weevil. By A. H. Friend. *J. Aust. Inst. Agric. Sci.*, 1945, **11**, No. 3, 139-141. (*R. A.E.*, 1947, **35**, A, Pt. 2, 35-36.) Derris gave some control.

Insect Powder. Brit. Pat. No. 570,537. *Soap*, 1946, **22**, No. 12, 163. Contains derris.

Lonchocarpus

Notes sur des Lonchocarpus. By E. De Wildeman and L. Pynaert. *Bull. Agric. Congo Belge*, 1946, **37**, No. 3, 586-597. Gives an account of a number of species and brief references to their reported uses.

Others

Response of Rotenone-bearing Devil's Shoestring, *Tephrosia virginiana* (L.) Pers., to Fertiliser Applications. By G. A. Russell and V. A. Little. *J. Amer. Soc. Agron.*, 1946, **38**, No. 7, 646-650. (*Exp. Sta. Rec.*, 1946, **95**, No. 6, 807).

PYRETHRIN-CONTAINING MATERIALS

The Story of Pyrethrum. By P. Jarrett. *Agric. Chem.*, 1946, **1**, No. 8, 27-29, 49.

A Note on the Weeding of Pyrethrum. By J. F. Perkins. *Kenya Pyrethrum News*, 1946, **1**, No. 2, 6.

Increase of Yield per Acre in Pyrethrum. By U. Kroll. *Kenya Pyrethrum News*, 1946, **1**, No. 2, 12, 14.

Constituents of Pyrethrum Flowers. XX. The Partial Synthesis of Pyrethrins and Cinerins and their Relative Toxicities. By F. B. LaForge and W. F. Barthel. *J. Organic Chem.*, 1947, **12**, No. 1, 199-202.

Refining of Pyrethrum Oleo-Resins. U.S. Pat. No. 2,413,107. *Rev. U.S. Pat. Pest Control, U.S. Dep. Agric.*, 1946, **19**, No. 12, 3. (Also in *Amer. Chem. Absts.*, 1947, **41**, No. 5, 1383.)

Ann. Rep. Dep. Agric. Kenya, 1945. Contains the Annual Report for 1945 of the Agricultural Officer, Pyrethrum Services, pp. 62-65.

The Determination of the Pyrethrin Content of Dilute Preparations of Pyrethrum Flowers in Oil. By G. T. Bray and K. A. Lord. *J. Soc. Chem. Ind., Lond.*, 1946, **65**, No. 12, 382-384.

The Determination of the Pyrethrins in Pyrethrum Concentrates in Mineral Oil. By J. T. Martin and S. T. P. Brightwell. *J. Soc. Chem. Ind., Lond.*, 1946, **65**, No. 12, 379-382.

Determination of Freon-Insolubles in Pyrethrum Extract. By L. D. Goodhue. *Soap*, 1947, **23**, No. 1, 133-135.

Production of Pyrethrum Sprays by Direct Percolation. *Kenya Pyrethrum News*, 1946, **1**, No. 2, 13.

The Formation of Insecticidal Films on Building Materials. I. Preliminary Experiments with Films of Pyrethrum and DDT. in a Heavy Oil. By E. A. Parkin and P. S. Hewlett. *Ann. Appl. Biol.*, 1946, **33**, No. 4, 381-386.

Note on the Efficiency of a Pyrethrum Spray in Controlling *Ephestia eleutella* Hb. Moths in a Granary. By R. W. Owen and N. Waloff. *Ann. Appl. Biol.* 1946, **33**, No. 4, 387-389.

Pyrethrum Research. *Kenya Pyrethrum News*, 1946, **1**, No. 2, 10. Pyrethrum applied at 2 galls. per 20 ft. is most effective spray for control of sod webworms in bluegrass (Abstracts of other literature given, most of which have already appeared in the Bibliography).

Housefly Control. By F. C. Bishopp and L. S. Henderson. *Leafl. No.* 182 (*Revised*), *U.S. Dep. Agric.* Refers to the use of pyrethrum sprays for the purpose.

Pyrethrum as a Mosquito Repellent. By C. G. Johnson. *J. Trop. Med.*, 1947, **50**, 52. (*Pharm. J.*, 1947, **158**, No. 4352, 205.)

Outdoor Control of Adult Mosquitoes with DDT or Pyrethrum applied with Ground Equipment. By A. H. Madden, A. W. Lindquist, B. V. Travis

Corresponding very closely in distribution with the central portion of the Protectorate described above, is a cover of lateritic ironstone, or duricrust as it is more properly called. This blankets rocks of all types without showing any appreciable difference in form or composition. It averages some 11 to 14 ft. on the lower levels and is up to 40 ft. thick or more on the peneplain relics. Outcrops are very few and far between; penetration of the duricrust cover is, moreover, a slow and laborious process. Where igneous and argillaceous rocks occur below the duricrust they are usually weathered down to 60 ft. or more, and it is on this fact that a lot of the water-finding by drilling is based. Recently Government has been persuaded to see the necessity for employing a drill for the examination of rocks and mineral deposits at depth; in most of the holes it is generally possible to combine exploratory drilling with the installation of pumps to supply water.

Communications throughout the country, in so far as they provide easy access to headquarters, are generally good. Indeed, it is possible in most seasons to go from one administrative station to any other in a matter of two or three days. At the same time there are still large tracts that are poorly supplied with roads or motorable tracks, and many areas are difficult to traverse except on foot. Progress may be hindered or even stopped by elephant grass, thorn scrub, lack of water in one place and excess of it in another, so that Uganda still has its full share of the difficulties that attend geological work in tropical Africa.

The Geological Survey

Except for a few brief descriptions of very limited portions of Uganda written in the main by Professor J. W. Gregory, nothing was known of the geology or mineral potentialities of the Protectorate before the Geological Survey was formed in 1919. Starting with very inadequate facilities, and despite much early official opposition, E. J. Wayland gradually built up a department which became indispensable to the economy of the country. During the latter part of his period of office, and subsequently, much greater appreciation of the value of geology was shown by Government, so that until quite recently the departmental staff in Uganda outnumbered that in any other Colony. As Kenya possessed no geologists before 1930, calls were made on Uganda for assistance at various periods, and it was Wayland's work, for instance, that led to the discovery of the Kakamega Goldfield.

A small drilling section was formed in the early days of the Survey, but at the end of 1929 it was transferred to the Public Works Department. In 1938, however, it was returned to our Survey and has since been expanded; in addition, several overseers have been employed on reservoir construction. An irrigation engineer is being engaged to deal with some of the water problems

together with swamp drainage and anti-soil erosion measures with which the department is concerned.

As in many geological surveys, shortage of staff has often prevented thorough investigation of problems, and laboratory work has particularly suffered in this respect. The inability to carry out much needed analyses has been overcome by the good offices of the Imperial Institute, which has greatly assisted us with this work and with advice on other problems ever since the inception of our Survey.

GEOLOGY

Much has been done during the war and subsequently to improve our knowledge of the systems which make up the geological column of Uganda, and it has been apparent for some time that the classification of the rocks of the Protectorate is intimately bound up with the succession in neighbouring countries. A. D. Combe consequently undertook an examination of the pre-Karroo rocks in these countries, and a memoir on the subject will be published later.

In the light of our present knowledge, the geological succession of the Protectorate may be represented as follows:

GEOLOGICAL SUCCESSION

Age	*Representatives*
PLEISTOCENE	Western Volcanics
PLIO-PLEISTOCENE	Kisegi Kaiso Beds
MIOCENE	Eastern Volcanics
POST-KARROO AND PRE-MIOCENE	Pre-Elgon Plutonic Complexes
KARROO	
PRE-CAMBRIAN TO EARLY PALAEOZOIC	Singo Series Bunyoro Series
PRE-CAMBRIAN	Granite Bulugwe-Samia Series Karagwe-Ankolean System Toro System Basement Complex

A great deal of additional work, however, still remains to be done, and uncertainty exists regarding quite considerable areas, as may be seen from the accompanying provisional geological map. A brief description of the above succession will now be given.

Pre-Cambrian to Early Palaeozoic

True *Basement* rocks are found along the eastern, northern and north-western borders of Uganda. These are paragneisses and orthogneisses together with various schists, granulites, quartzites and marbles. It is highly probable that volcanic as well as sedimentary and plutonic rocks are represented.

A series of quartzites and mica-schists which occur along the Uganda-Sudan border are thrown into a series of folds, which form, in their relationship to the river system and vegetation, a model lesson in the effect of rocks and structure on the landscape. These rocks, which were formerly called the Madi Quartzites, were

thought at one time to be the equivalents of the Toro Quartzites in the region to the south. They have recently, however, been shown to be folded conformably in the Basement rocks of the neighbourhood. The Basement also includes charnockitic types both in the east and west of the country. Apart from work in the country west of the Albert Nile, no mapping has been undertaken in areas made up of these earliest of Uganda's rocks.

The Basement rocks are followed by the *Toro System*, which has been observed mainly in the western part of the Protectorate. This rock group, which is often responsible for a very characteristic topography, consists of quartzites, grits, rare conglomerates, mica- and chlorite-schists occurring in high-dipping, tight folds and is so closely related in space with the later Karagwe-Ankolean System as to suggest the persistence of geosynclinal basins. It seems certain, however, that the Toro System is confined to the south-west quadrant of the country and does not extend so far to the north and west as the Karagwe-Ankolean. These rocks are possibly the equivalents of the upper Basement of countries to the south and are thus amongst the earliest of the pre-Cambrian System of Africa.

The Toro System is followed by the *Karagwe-Ankolean System* (known in neighbouring countries as the Muva-Ankolean), which is Uganda's most important group of sedimentary rocks. It is most prominently developed in the south-west of the Protectorate and is also represented as a band along the north side of Lake Victoria, and another running in an east-west direction in the region of Lake Kyoga ; it is also found over wide areas in the Congo, Northern Rhodesia, and to a limited extent in Tanganyika. The rocks occur both in folds and as low dipping or horizontal beds, and consist of quartzites, sandstones, conglomerates, grits, shales and mudstones. Where the System lies near later granite masses, phyllites and mica-schists occur. These Karagwe-Ankolean rocks are invariably related to the " arenas " of E. J. Wayland's descriptions, in other words areas formed by high, roughly circular walls of Karagwe-Ankolean rocks, with quartzite in the cores, surrounding depressions underlain by granites and schists. The rocks of this age are associated with much doleritic material in the region around the source of the Nile at Jinja, intruded apparently in the form of sills. The System is usually called, for the sake of brevity, the K.-A. ; it has been tentatively correlated with the Witwatersrand System of South Africa.

In the extreme south-east corner of Uganda two groups of rocks are developed, which, though similar to the Karagwe-Ankolean in possessing quartzites, grits, mudstones and shales, are often markedly different in their further additions of volcanic rocks and banded ironstones. These groups are like the so-called " Nyanzian " and " Kavirondian " of the Lake Victoria areas of Kenya and Tanganyika which carry gold deposits in those territories. In Uganda these rocks have been divided into a lower or *Bulugwe*

Series (Nyanzian) and an upper or *Samia Series* (Kavirondian). Further work is being carried out by A. D. Combe on the area linking the known sedimentary K.-A. and the Bulugwe-Samia rocks.

The K.-A. is succeeded in turn by the *Bunyoro Series*, which is unconformable on the earlier system along a belt west of Lake Kyoga. These beds are mainly of glacial origin, and include tillites and finely varved sediments; they have been correlated with the tillite of the Pretoria Series of South Africa. The validity of this comparison is being further tested, but at least it may be said that, in the absence of fossils, glacial beds might be expected to form a very useful means of correlation over considerable distances. This series, therefore, is thought to be late pre-Cambrian. Tillites are of course known at several horizons throughout Central and South Africa.

The highly folded rocks of the K.-A. are overlain in several regions, usually of a plateau-like nature and limited to small areas near the western and north-western shores of Lake Victoria, by a flat-bedded series of sandstones with subsidiary siltstones and shales; these have been called the *Singo Series*. They include what were formerly known as the Mityana and Butologo Sandstones and are the equivalents of the Bukoba Sandstones of Tanganyika Territory; they carry in the siltstones problematical algal forms resembling *Collenia*. The Singo Series may be of any age from late pre-Cambrian to early Palaeozoic. On the other hand, A. D. Combe has suggested, on the basis of the Belgian Congo succession, that they may represent the upper portion of a System (Katanga System of the Congo) of which the lower part of the upper half includes the *Bunyoro Series*. The Singo Series exhibits many features of resemblance to the Waterberg System of South Africa.

Those who read the account of the Gold Coast geology by N. R. Junner in this BULLETIN[1] will be struck by the similarity of the descriptions of the Singo Series and its relationship to the Bunyoro Series and the account of the Voltaian of the Gold Coast. All these correlations can of course only be regarded as tentative, but even so attempts at such comparisons may help us to arrive at a clearer conception of the geology of the continent as a whole.

Granitoid rocks underlie at least half of the Protectorate. Their age in many areas is uncertain, though possibly a third are later than the Karagwe-Ankolean. No granites are known that have intruded later formations. Granites of three ages are known in the area of south-east Budama along the Kenya border, where their relationship to mineralisation can be closely defined. Marginal problems related to these plutonic masses abound.

Dolerites of several ages and showing varying degrees of alteration also occur, though here again it seems doubtful if the great majority are much later than the latest granite which they intrude.

[1] "Progress in Geological Investigations and Mineral Developments in the Gold Coast." By N. R. Junner. *Bull. Imp. Inst.*, 1946, **44**, 44-65.

Karroo

A long gap in the geological column occurs between the Singo Series and the Karroo beds, which are equated with the period from the Upper Carboniferous to the Jurassic of Europe. Only three small patches of these rocks have so far been found, the largest of which, that on Dagusi Island, being some 4 sq. miles in extent. The sediments underlying Entebbe are mainly blue, black or grey shales with subsidiary grit bands; they are flat bedded or gently dipping and belong to the Ecca subdivision of the Karroo, which is coal-bearing in countries to the south of Uganda and believed to be of Permian age. Carbonaceous shales occur in the beds at Entebbe, which are at least 1,400 ft. thick. Another patch of Karroo was found to be only 82 ft. thick; the third has yet to be drilled. Infaulting is suggested for the preservation of beds of this age.

Post-Karroo

No rocks of Jurassic or Cretaceous age are known in Uganda, though elements in the topography almost certainly date from that period. A peneplanation probably of Jurassic age is observable in several parts of the Protectorate.

Along the eastern border of Uganda, however, occur four areas of plutonic complexes rich in calcium and soda, of which at least three possess carbonatite cores. At least one other occurrence of this type also including carbonatite occurs under the agglomerates of Mount Elgon. These complexes, which are circular in outline, represent old volcanoes of post-Karroo and pre-Miocene age.

The earliest known strata of Tertiary age are the beds that form the base of the Mount Elgon succession and which have been classed by R. Chaney as Middle Tertiary; they have elsewhere been called the Bugishu Series. It seems from other considerations that these can more nearly be placed in the *Upper Miocene*.

Other volcanoes which stretch in a north-south line along the eastern border of Uganda into the Sudan are apparently of approximately the same age as Elgon, in addition to many related hypabyssal and plutonic, consanguineous occurrences. The evidence therefore points to the persistence of a widespread magma reservoir of calc-soda type throughout a long period of time. Later volcanic dykes and flows in the north-east corner of the Protectorate, however, include some true dolerites and basalts. One very striking feature is the close association of biotite-pyroxenites with the rocks of both the earlier volcanoes of the eastern border and those of the later potash-rich vulcanicity of the south-west of Uganda so ably described by Professor A. Holmes.

The *Kisegi* beds of the Albert Rift on the western side of Uganda are probably of Pliocene and Plio-Pleistocene age. They are mainly arenaceous sediments at least 1,000 ft. thick, and cover an area of about 5 sq. miles around the northern extremity of Ruwenzori. One oil seepage is known to occur within them.

The *Kaiso* beds, which overlie the Kisegi, cover by far the greater part of the Albert and Edward Basin areas and have been proved to have, together with possible Kisegi beds, a depth of at least 4,040 ft. near Butiaba. They are argillaceous in character, but with subsidiary arenaceous beds, and possess thin lignite bands at their base in the Ruwenzori area.

The Kaiso beds carry mammalian and other fossils in their upper portions which indicate an age of about Lower Pleistocene. Mud volcanoes, gypsum deposits, salt and sulphur springs and petroleum seepages are associated with the Kaiso.

Many terrace, riverine and lacustrine deposits continue the geological narrative from the middle peneplain of Miocene times. This fascinating story has been described largely by E. J. Wayland in his investigations of the prehistory of Uganda. Evidence of warps, faults and reversal has been found, though in the light of recent work it seems that the riverine history of Uganda must also owe a good deal to capture.

Mineral Development

Uganda, unlike many other Colonies, has not seen a rapid development of mineral deposits. So far the indications are that it is a country of diverse, but small deposits, and unfortunately these tend to attract the smaller and often unsatisfactory type of operator. The position is also complicated by the fact that in Buganda, which forms 21 per cent. of the total area of the Protectorate, the mineral rights over the greater part of the Province are held by the innumerable native landowners. No minerals were exported until 1927, when cassiterite was first discovered, and between that date and the end of 1945 the value of mineral exports was £2,380,000. It may be pointed out that more than one-third of the minerals already produced has been due directly to original discovery by members of the Survey. In this respect it can be stressed that whereas the Geological Survey, since its inception in 1919, has cost the Uganda Government £188,000, some £166,000 has been gained as royalties and in mineral rents and fees ; there is every indication too that the gap is fast closing. Moreover, the last-named figure does not take into account the phosphates exported since the end of 1944 because these are the subject of direct sales to Kenya by the Uganda Government.

The emphasis on the kind of minerals required has, of course, varied with the demands of war and peace. In 1939 gold, tin ore, columbite-tantalite, and a very little wolfram and bismuth ore figured on the list of exports. During the war the wolfram exports were stepped up considerably, and mica, beryl, amblygonite, bismutotantalite and phosphates added.

The Karagwe-Ankolean System is the most important from the mineral-bearing point of view, but the precise stratigraphical

relationship will now be dealt with in a brief review of the several minerals.

Tin

Tinstone has formed Uganda's most consistent mineral export and some £1,232,200 worth has been exported between 1927 and the end of 1945; the total export value, however, is likely to be overhauled by that of gold during the next few years. The cassiterite occurs in veins of quartz, and of muscovite and kaolin intruding the K.-A.; the masses of mica and kaolin associated with some of the deposits indicate derivation from the alteration of pegmatites. So far all the ore has been won from veins and eluvial deposits on hillsides, but the majority of workings are on a very small scale, and Uganda possesses only one underground mine. It has been shown that it is possible to correlate the tin-producing granites from an examination of their petrographical and chemical characters.

Gold

Although gold was not discovered in Uganda until 1931, up to the end of 1945 £899,800 worth had been exported. Nearly all the earlier production was obtained from alluvial deposits connected with tiny veinlets in the Toro-K.-A. Systems of the south-west corner of Uganda, some of the gravels being phenomenally rich. No workable veins were found, however; in fact, no payable vein has yet been discovered in the true K.-A. or Toro Systems in Uganda. On the other hand an area in the Bulugwe Series near the Kenya border carries numerous gold bearing veins which have yielded large quantities of gold from open-cast workings, and work is now commencing with the aim of exploring the lodes at depth. This mineralisation is of the same age as that of the goldfield of Kenya and Northern Tanganyika.

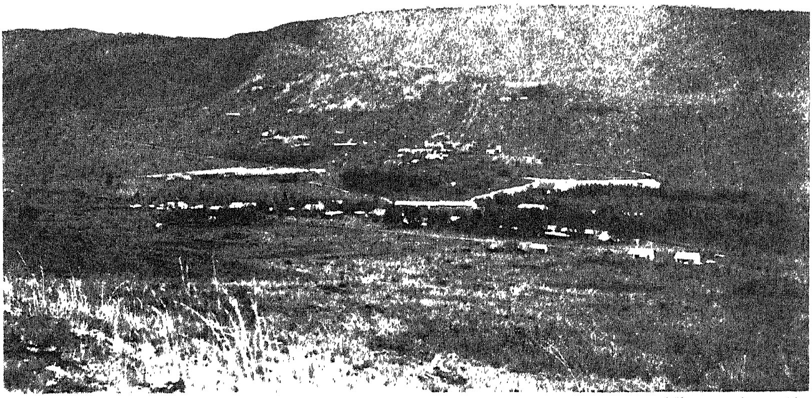
Wolfram

Wolfram was first discovered by a prospector in the Kigezi district of South-west Uganda in 1931, but none was exported until 1935. The growing interest in the mineral at the beginning of the war caused further search, and more discoveries were made in the region of the original find. Wolfram was discovered by the Survey in the Buganda area, which led to the opening up of a number of workings there. As with all mining activity in the Protectorate, progress in the production of wolfram was painfully slow, but finally the output grew to nearly 100 tons a year. Improved methods of working could ensure quite double this output, and it seems that other finds of this mineral could be made by close prospecting.

Tantalite-Columbite

Uganda possesses a variety of minerals containing tantalum and columbium. High grade tantalite was discovered in 1926 and

PLATE I.

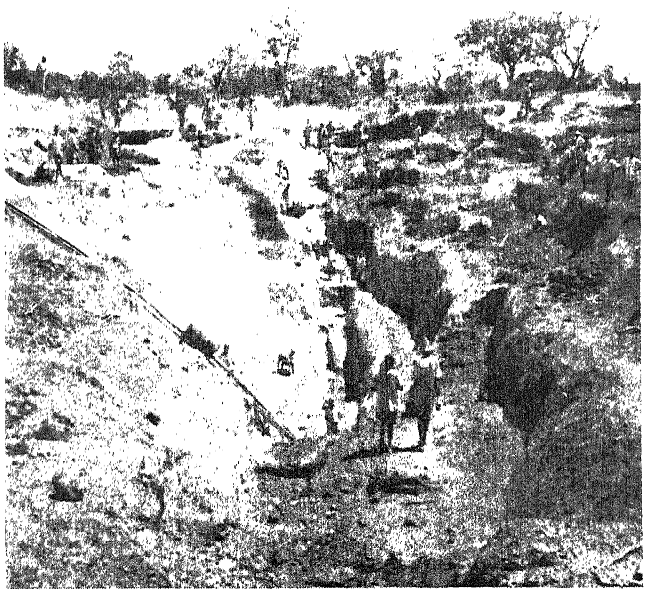


[By courtesy of Kagera Mines, Ltd.

TIN MINING IN UGANDA.

General view of Mwirasando Mine, from which the bulk of tin concentrates produced in the Protectorate is obtained.

PLATE II.



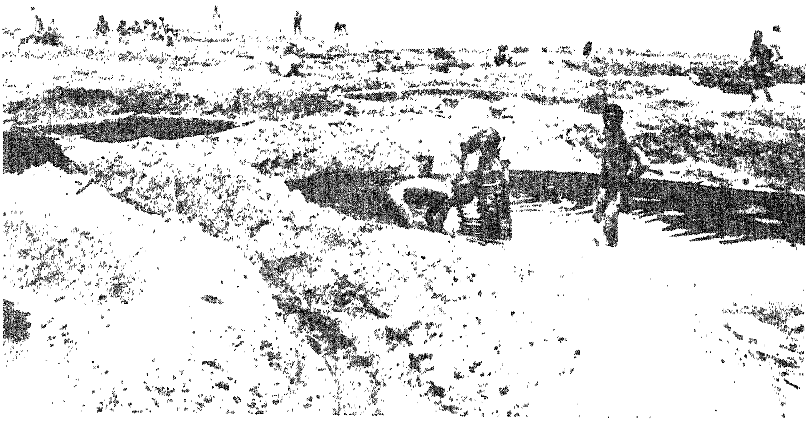
[Photo: H. J. R. Way

GOLD MINING IN UGANDA.

Open-cast workings for auriferous quartz, Busia Goldfield, Budama, Eastern Province.

[facing page 168

PLATE III.

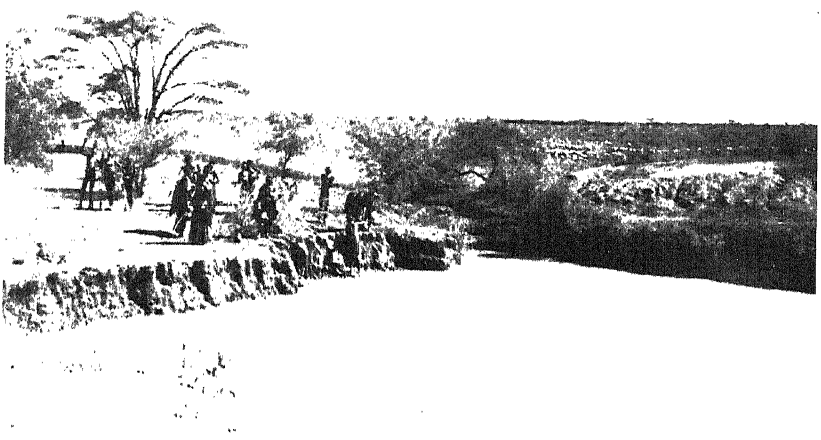


[Photo: A. S. Thomas, Agricultural Dept., Uganda

WINNING SALT IN UGANDA.

Natives obtaining salt from Lake Katwe, a volcanic crater lake near the south end of Ruwenzori.

PLATE IV.



[Photo: C. B. Bisset

WATER TANK IN KARAMOJA, UGANDA.

The construction of water reservoirs, or tanks, similar to that shown above, forms part of the many activities of the Geological Survey, Uganda.

bismutotantalite in 1928, but no export of columbite-tantalite minerals took place until 1936 when ore to the value of £5,687 was exported. Some 27 tons were produced in 1937 (value £6,092), largely ore containing about 40 per cent. tantalic oxide. The trade in these minerals, however, gradually fell off with the uncertain prices, and, when war demands grew, the same difficulty of slow progress was met with as in the case of the other minerals; so that even at the best period (1944) only 6 tons of tantalite and 13 of columbite were produced.

One reef found in the Ankole district yielded probably the world's highest grade tantalite of exportable amount (83·39 per cent. Ta_2O_5). Columbite and tantalite are usually associated with tinstone in the pegmatites cutting the K.-A. and Toro rocks, though tantalite has been found in lodes without any tinstone.

Phosphate and Associated Minerals

Huge apatite deposits are associated with the old volcanoes of pre-Elgon age, and exploitation was commenced in the later days of the war to supply the needs of East Africa. At one of these occurrences about two-thirds of the apatite is carbonated and shows a fair degree of citric solubility. The material is thus crushed and used as a fertiliser in this form. Some 5 million tons of rock bearing between 8 and 35 per cent. P_2O_5 have been estimated to occur in the area where quarrying is carried on, and this forms only a small proportion of what must be available in the deposits as a whole; this locality, however, apparently carries the highest percentage of carbonated rock. The phosphate is associated with even larger tonnages of *magnetite* and a lesser amount of *phlogopite* mica. The last named has weathered to form *vermiculite*, but tests on material dug out from one or two pits seem to show that it is not of high grade. It is intended to manufacture " sodiophosphate " by combining the phosphate with the soda of Lake Magadi in Kenya. The ground rock has recently been produced at the rate of 10,000 tons a year.

Judging from samples obtained from drill cores in the area of these old volcanoes, it seems possible that *bauxite* may also be found.

Salt

About 3,000 tons of salt are produced annually from lakes which lie in craters of recent origin at the south end of Ruwenzori. This is a native industry and the quality of the material leaves much to be desired. Schemes for improving the quantity and the quality have been drawn up, but are likely to meet with political difficulties in implementing them. Some *potash* salts could be recovered from these deposits.

Other Minerals

Mica was worked at a small profit during the war, and during

1944 an output of a ton a month of cut mica was achieved from one mine only.

Beryl occurs in two pegmatites in the Buganda area associated with columbite and other minerals, and these occurrences yielded 18 tons during 1944.

Amblygonite also occurs in sufficient quantity in several places to be exportable if a market can be found.

Sands and clays of high grade, which Uganda possesses in abundance, have been exported to Kenya for pottery and other purposes, while some have been used locally.

Quartz crystals are associated with veins and cavities in low-dipping K.-A. sandstone and have been found as pebbles in alluvial gravels which were being worked for gold. A few hundredweights of high grade crystals have been exported, but the search for this material has proved on the whole disappointing.

Bismuth ore occurs in association with wolfram and tinstone, and a few hundredweights have been produced.

The occurrences of *petroleum* and *copper* are dealt with on pp. 172.

Water Supplies

The departmental work on water supplies is mainly concerned with drilling and the construction of reservoirs, though formerly an overseer was also employed on the improvement of springs. The Department possesses a drilling section with a drilling engineer and a staff of ten drillers and mechanics; in addition, eight drills belonging to a company are employed on contract. Boreholes supply the smaller townships and rural agricultural communities, as long distances had often to be traversed by the natives to obtain water. Altogether there are 627 of these watering points in the Protectorate, the percentage of successful holes at present being approximately 85. The average depth of the holes is roughly 150 ft., and the cost is about £330 for a hole fitted with a hand pump.

The construction of reservoirs has been confined largely to cattle country, though there is a growing tendency for communities who pursue mixed farming to demand this form of supply. Three types have been constructed, namely:

I. Tanks holding some 50,000 gallons dug on bare hillsides, with inflow trenches to increase the catchment.

II. Holes dug on slopes with the spoil thrown out in a crescent on the lower side of the excavation, with inflow trenches to ensure a greater inflow; these may hold up to half a million gallons.

III. Dams built at suitable places across valley bottoms, usually with a large tank dug below ground-level just on the upstream side of each dam. The largest of these reservoirs so far constructed has recently filled; it holds 460 million gallons.

Formerly, the construction of these reservoirs was carried out largely by hand labour, but it is hoped that in the immediate future the use of earth-moving machinery will gradually supersede the older and slower method. So far, 120 of these watering points have been established throughout the country.

Payment for the installation of water supplies has hitherto been made from Protectorate and Native Administration Funds, but recently a grant of £279,000 has been made from the Colonial Development Fund towards the cost of this work. This will undoubtedly be increased when the Protectorate Development Scheme comes to fruition.

Future Problems and Development

Uganda presents a list of fascinating problems of academic and economic importance. Many problems, too, which have seemed academic have later proved to have a considerable bearing on the economic geology.

It goes without saying that the betterment of our knowledge of the stratigraphical column should take first place; with this is linked the problem of the granites. Much doubt still exists regarding the relative age of some of the earliest of the sedimentary rocks, and large areas of the Protectorate underlain by them still remain to be examined.

Further work must also be done on the very important question of the relationship of the normal K.-A. to the Nyanzian-Kavirondian and other series in neighbouring territories.

Information is required too concerning much of the country surrounding the Glacial Series. These beds rest on what are presumed to be K.-A., but both series possess similar strikes. Certain sediments which crop out on the west side of the area concerned are dissimilar to the typical rocks of both groups, and may even represent a normal subaqueous development pene-contemporaneous with the glacial series. It seems certain that one or two boreholes should assist considerably in solving this question.

Further occurrences of Karroo may be expected in the region along the north shore of Lake Victoria, but it seems probable that they will be of very limited extent. In some places these patches are downfaulted, but in others they sit on older sedimentary rocks. It is unfortunate that the region in question is amongst the most difficult in the whole of the Protectorate, because the search is hindered by thick layers of duricrust and weathered rock, dense vegetation, and over the eastern portion, by tsetse fly.

At a higher level in the stratigraphical table other problems arise. Sandstones occur in the beds of streams overlooking the Albert Rift which are probably Tertiary in age; these may possibly be correlated with some of the earliest beds of the Rift itself.

Problems of petrogenesis abound amongst the most recent igneous rocks both on the western and eastern sides of the country.

Some of these rocks at least are better exposed than is usually the case in Uganda.

Much work, too, remains to be done on structure, topography and prehistory.

Problems concerning the development of mineral resources are concerned mainly with products which so far have not been produced for export. Chief amongst these is petroleum, which is known to occur in the Kaiso and Kisegi beds of the Western Rift. From one hole drilled by a prospecting company in 1939, oil welled up slowly. Circumstances caused a premature closing down of the operations, but it is the intention of the Department to do scout-drilling to some 2,000 ft. around the northern nose of Ruwenzori and on the Semliki and Kaiso plains. Investigations by drilling will also be undertaken on the Karroo beds lest any possible coal bands be missed.

Copper deposits occur on the flanks of Ruwenzori. These are associated with biotite-granulites, presumably of Toro age, intruded by alaskites. A good deal of preliminary work has been done on these lodes and an estimate reached of 1,660,000 tons of ore carrying 4·21 per cent. copper, 0·37 per cent. cobalt and 0·02 per cent. nickel. Exploration was carried down only to about 300 ft., but further work is now being undertaken. The Ruwenzori range might be expected to carry other mineral deposits, but the knife edge spurs, deep valleys and dense vegetation make prospecting a herculean task.

The Department usually employs at least one full-time prospector. He is engaged in following up traces of mineralisation which are indicated by the work of the geologists.

Wide areas in the Protectorate remain to be examined, but conditions for prospecting are not easy. On the analogy of the occurrences in the better exposed, short grass country of the south-west it might be expected that tinstone would occur in the K.-A. of Buganda. It has been recorded in small amounts from the alluvials of some of the streams in this area, but no reefs have yet been found. Gold is already being worked in Buganda, and mining claims have already been granted to a company over the Kafu River which delimits the Buganda Kingdom on the north. Pitting and drilling by the Department on this river have proved values of gold worth following up.

An example of the bearing of one branch of technical work on another is seen in the measurement of isogonic lines throughout the Protectorate. These disclosed magnetic anomalies in the Tororo area and in an area in Buganda near the north-west corner of Lake Victoria. The anomaly in the region of Tororo is, of course, explained by the enormous magnetite deposits which are associated with the old volcanic centres already described. The other area is little known geologically and the reason for the marked deviatien of the isogonic lines is not known.

It seems probable that the only payable gold and tin workings will be confined to the southern half of the Protectorate. Here, however, the swamps often carry very deep alluvial deposits and much work by drilling remains to be done on these water courses.

Numerous other minerals occur in Uganda, which, in some instances, might be brought into production if prices were favourable. It is obvious, however, that as the nearest part of the Protectorate is 700 miles from the seaboard the working of low-priced minerals is not likely to be encouraged.

It may be said in conclusion, then, that Uganda offers a host of fascinating problems, the solution of which will undoubtedly attract the attention of geologists the world over.

DISCUSSION

In the unavoidable absence through sickness of **Sir Bernard Bourdillon,** G.C.M.G., formerly Governor of Uganda, the Chair was taken at short notice by **Sir Edmund Teale,** who, in introducing the lecturer (Mr. C. B. Bisset), referred to his long experience in East Africa, first in Nyasaland, and later in Uganda. Mr. Bisset also had a special commission from the Tanganyika Government for inquiring into their water supply. He drew attention to the fact that Uganda was the first country by a good many years to start official geological work in East Africa.

After the lecture the Chairman remarked on the great diversity of mineral occurrences in the Protectorate, and also the diversity of activities that the geologist was called upon to undertake in the development of such regions—engineering, industrial, agricultural, social, as well as many other activities. He was impressed by the wonderful scenic views of Uganda which the lecturer had shown on the screen, and said that he would like to open the discussion by asking one or two questions. He would like to know, for instance, if the lecturer was of the opinion that geophysical methods of prospecting, so successfully used with regard to water supply investigations, could be applied with advantage to certain mineral areas, such as the copper occurrences at Ruwenzori, where the deposits were hidden in large measure by a lateritic cap.

With regard to the water supply activities, so ably described by the lecturer, Sir Edmund welcomed the illustrations showing the small dams for cattle in the black cotton soil, and inquired as to how the cattle were kept out, as otherwise they would soon break down the sides and pollute the water. He would also like to ask the lecturer if experiments had been carried out in Uganda with the object of holding up seepage water in the drier areas where "sand rivers" occurred by putting a submerged dam under a suitable geological site.

In throwing the meeting open to discussion, the Chairman said he was sure that Mr. Wayland, whose name would always be

remembered in connection with Uganda, would have something to say about his old stamping ground.

Mr. E. J. Wayland congratulated Mr. Bisset upon his admirable account of the work of the Geological Survey of Uganda, but feared that while the lecturer had been overpraiseful of his (Mr. Wayland's) efforts in that field, he had carefully hidden his own light under a bushel.

Speaking with first-hand knowledge, however, the speaker could assure the audience that Mr. Bisset's own contribution to the work of the Uganda Geological Survey was not only large, but of great and lasting value, particularly in the sphere of that all-important prerequisite to development in so many parts of the tropics, water supplies.

The Chairman had told them that Uganda was by a good many years the first among the East African British dependencies to start a Geological Survey. That was because toward the end of the first World War the speaker gave up a commission and left France in order to visit Uganda in the interest of the Ministry of Munitions. He could not fail to be struck with the promise of the Protectorate, nor to be enamoured of its then untackled geological problems. So he stayed to work there for 20 years. It was during the latter part of this period that Mr. Bisset came to them from Nyasaland.

The speaker said that in his opinion, and as far as his knowledge went, Uganda was the finest part of Africa, and it would be difficult to name another territory in that continent comprising such striking contrasts. There were the plains of the Eastern Province, the great block mountain of Ruwenzori, snow-capped and more than 16,000 ft. high, and immediately to the north of it the Albert Rift, the rock bottom of which, now thickly covered by sediments, was some 2,000 ft. below the level of the sea. There were the dense tropical gorilla-haunted forests of the south-west and the semi-desert country of Karamoja in the north-east; the dissected plateaux of Ankole and the towering volcanic peaks of Bufumbira and of the Congo beyond, one of which it was his good fortune to ascend (in excellent company) while it was in eruption. Nor did these examples by any means exhaust the scenic and other natural attractions of the country. Indeed, they were so many, and some of them so beautiful, that one could grow lyrical in trying to describe them.

Ankole was the cattle country of the western part of southern Uganda; it was also the tin-producing area of the Protectorate, and they named the country rocks that enclosed the lodes the Ankolean System. These consisted, for the most part, of phyllites, shales and quartzites of very great antiquity. It was soon discovered that these strata were continuous with the Karagwe beds of Tanganyika Territory which were originally described and named by the late Professor J. W. Gregory. In order, therefore, to preserve the terminology of this great pioneer, they modified their nomen-

clature and called this system the Karagwe-Ankolean—an ugly name, no doubt, but justified. An attempt was made (not with the best reasons he thought) some years before the second World War to persuade them to alter this name to that of Muva-Ankole, or Muva. The speaker resisted this and he was very glad to learn that afternoon that the term Karagwe-Ankolean (or K.-A.) still held the field in Uganda.

The difficulties of geological investigation in Uganda had been mentioned. They were not confined to that Protectorate, of course, but there they displayed two extremes: on the one hand, that of dense jungle-like forest with a thick vegetal ground cover, as in the case of Ruwenzori; and on the other vast, flat stretches of lateritic ironstone like those of the Eastern Province. He well remembered one of the geological officers, an extremely keen and able collector, sending to Headquarters almost the only specimen he was able to gather on a traverse over Ruwenzori. It was a chunk of not very fresh rock supporting, on all sides but one, a miniature forest of moss. It seemed a little out of place among the naked specimens in the Petrologist's store, so "Bill" Simmons (number two in the Department in those days) covered that bit of Ruwenzori with a bell jar so that he might tend and cultivate the verdant moss. What treasured crumbs of biological learning were thus obtained the speaker could not say. It was not too much to claim, however, that the said collector's reaction when he beheld his treasure treated, as he thought, like the last bun in a station restaurant, was to enrich their vocabularies beyond all description.

He recalled an occasion in the Eastern Province when, halting to camp one evening, he picked up a bit of shale. It might have passed easily for K.-A., but it could have been Karroo—they knew of Ecca shales in the Entebbe Peninsula—but apart from one tiny patch in a gully there were no helpful exposures. In the circumstances one had to rely on included fragments in the ironstone blanket of the area, so some 50 natives were employed to collect and split these in the hope of finding fossil remains. Many thousands of fragments were thus dealt with, but no trace of a fossil was discovered in spite of two days intensive search. On the morning of the third day, however, just as they were moving on again he cracked a final fragment, "just for luck," and thus revealed an impression of part of a *Glossopteris* leaf. The shale was therefore Karroo, and the possibility of coal was thus established. These, then, were two examples of the difficulties of geological inquiry in Uganda.

No coal of any consequence had yet been found in the Protectorate, but he was glad to learn that investigations in this regard had not been abandoned.

Generally speaking, Karroo coals traced northward from well-known South African fields, seemed, on the whole, to thicken somewhat until they reached a maximum in the Bechuanaland-

Wankie area. Vast, untapped and remarkably thick deposits were known to exist in Bechuanaland. Then, still tracing them northward, they tended, in general, to thin out. This might prove unfortunate for Uganda, but clearly the matter demanded investigation.

Although no authentic coal finds of consequence had yet been made in Uganda, some remarkable, if mistaken, coal discoveries had been made. One such case came to the notice of the Protectorate Government in 1919. The then Governor, the late Sir Robert Coryndon, was anxious for mineral development and called for a report on this coal find as soon as possible. In response to this the speaker set off for Sango Bay on Lake Victoria (the site of the alleged discovery) where he was joined by the discoverer and an interested party (a mining engineer). While he made camp, the discoverer and the mining engineer collected a sample of the so-called coal. Some of this he heated in a closed tube, with the remarkable result that large quantities of steam were evolved and the residue was completely magnetic. Consequent upon this he submitted the shortest of all his reports. "This mineral," he wrote, "if ground up and cast into a fire might prove an excellent extinguisher, as a fuel it is useless."

Another sample of so-called coal produced from another part of the Protectorate proved to be tourmaline and led to the discovery of an economic mineral new to science, namely, bismutotantalite.

The lecturer had told them that gold was discovered in Uganda in 1931. Doubtless he meant that workable gold was first found in that year. Gold was certainly known to occur in the Protectorate at least 40 years ago, and about 1906 there was a small rush to a place on the escarpment above Butiaba. It came to nothing, however.

Perhaps the most important economic mineral discovery in Uganda was that of the phosphate deposits found by the present Director, Dr. K. A. Davies. They hoped to hear more of them later.

With regard to other types of mineral fertilisers it might be mentioned that what was perhaps the largest potash deposit in the world occurred in the south-west of the Protectorate and in the Congo beyond; but the substance was locked up in certain primary minerals, such as leucite, in the lavas and was unlikely to be worked for a very long time—if ever.

From potash, the speaker next turned to petroleum, and here he had a complaint to make. Two types of petroleum, one (the older) with a paraffin base and the other with an asphalt base, were known in the sediments of the Albertine Depression. Gas was associated with both. The younger oil, found in loose Pleistocene sands, was "pockety" and very viscous; the older was of more normal occurrence. There were, too, some structures which could accumulate such oil as might be present. The chief of these

was the Waki dome, of which they had seen a picture on the screen. A company came to test this dome, and the area generally, from the point of view of its oil prospects. It was agreed that the first trial bore was to penetrate the Waki dome, for here, if anywhere, according to the speaker's view, oil should be found. It would appear, however, that those responsible for siting the bore accepted the surface of a thick but lenticular sand bed as a tectonically produced flexure with the result that, according to his own interpretation, the borehole missed the true dome structure entirely, and with it any petroleum reservoir that might be present. He was pleased to learn that the Uganda Geological Survey had not completely abandoned hope in that direction.

From one liquid mineral substance, the speaker said he would like to turn for a few moments to another of still greater importance; that was water. It was perhaps not only the most precious mineral on earth but, likely enough, the rarest substance in the universe. He need hardly say that the boon that water brings to otherwise dry countries was unparalleled in the tropics. That was a matter which had engaged much of the lecturer's time and close attention, and the speaker would like to remind those present that it was chiefly under Mr. Bisset's guidance that the percentage of successful boreholes in Uganda shot up from less than 50 to over 80. The speaker happened to know that the lower percentage resulted largely from drilling on sites chosen by a dowser, while the higher percentage resulted from scientific selection.

A Geological Survey had many activities, and in this regard the lecturer had mentioned that a seismograph had been installed at Entebbe. But the Uganda Geological Survey did much more than that. They caused a seismological observatory to be built with two storeys underground and one above ground, and for years they worked with paired seismographs, with interesting, and, he ventured to think, useful results. The greater share of that work fell to Mr. W. C. Simmons, who originally suggested that the inquiries should be undertaken. They were a link in the chain of seismological stations, and their results were sent to Professor Turner, of Oxford.

In its early days the Geological Survey of Uganda was looked upon as a luxury, for which reason attempts were made to close it down, and it was interesting to note that they were later to obtain their strongest support from those who had at first opposed them.

At one period the "Powers that Be" attempted to put the East African Geological Surveys (there were two at the time) under other departments. They of the Uganda Geological Survey resented this for good reasons and dug in their heels to a man. They were prepared to face dismissal rather than defeat in that matter. They won through. To their dismay, however, the Tanganyika Geological Survey did otherwise, and now, after many years, were very rightly trying to regain their early, healthy independence. They must

wish them all success, not merely for personal reasons, but mainly because, as the lecturer had so ably shown, if you wanted development you could not afford to discourage your Geological Survey, assuming you were wise enough (and nearly all countries were these days) to have one.

Dr. H. J. R. Way congratulated Mr. Bisset on his excellent lecture and very fine illustrations, and said that he had had the privilege of collaborating with him in Uganda for a number of years trying out the resistivity method of geophysical surveying and applying it to the selection of borehole sites. This resistivity work was not restricted to water supply problems only, though it was of great importance in this respect; the speaker had, indeed, used it for prospecting argentiferous gold-bearing reefs close to the Kenya border. Whilst he did not claim a conspicuous success for this work, three extra reefs were discovered in this way, one of which was definitely gold-bearing. He believed that further work on these reefs since he had left the country had resulted in the production of a certain quantity of gold.

One of the points that had been brought out by the lecturer was that a lot of money had been voted through the benevolence of the Home Government for geological work throughout the Colonial Empire, but that full advantage could not be taken of this at present on account of the difficulty of recruiting trained staff. The speaker emphasised the utmost importance of training sufficient geologists and geophysicists to take up positions in the future, thus enabling the money voted for geological work to be used to the full. These positions should, of course, be made attractive to potential recruits, and he hoped that, as the status of geologists in the Home Survey had been improved recently, similar action would be taken within all the Colonial establishments.

Mr. G. E. Howling, Principal of the Mineral Resources Department of the Imperial Institute, said that he would like to comment on a couple of minerals that had been mentioned casually, namely, bismutotantalite and quartz. Bismutotantalite had a unique history. It was discovered in Uganda in 1928 and the first specimens were sent to the Imperial Institute for complete investigation. It proved to be a mineral new to science, but was of very little commercial interest at that time. During the recent war, the exceptional demand for tantalum led to the working of Uganda bismutotantalite for export to the United States, and the small eluvial concentration at Nampeyo Hill near Kampala was exhausted. Unless other deposits come to light this mineral would therefore revert to the position of a curiosity.

Mr. Bisset had mentioned the occurrence of quartz in Uganda, but since quartz was so ubiquitous, some of the audience might have wondered why he should have mentioned it. The interest in Uganda quartz lay in the fact that quartz crystals had been found there which possessed piezo-electric properties in a marked degree.

Since we were dependent on Brazil for supplies of this type of quartz which was in great demand, especially during the war, for many electrical devices used, for instance, in tele-communications, in depth-sounding and in submarine detecting, the finding of suitable quartz in the Empire would have been an asset of the first importance. When about 20 years ago Mr. Wayland sent about 1 cwt. of these crystals to the Institute for a report on their possible uses, the speaker remembered picking out about half a dozen of the most promising looking pieces to send to a leading electrical firm for testing. This firm actually had to send them to France for cutting into plates for piezo-electric tests. The final report, however, showed that they possessed this property in very marked degree. Therefore, during the recent war when the demand for such material became acute and the whole Empire was combed for likely sources of this type of quartz, Uganda was regarded as the most likely place in which to find it. Unfortunately the result was most disappointing and only a very small amount of suitable quartz was forthcoming. In Uganda the quartz crystals came from streams where gold washing operations were in progress and the crystals had been rounded by abrasion in water, the surfaces being like ground glass so that the interior could not be examined on the spot for internal flaws and the exterior for signs of twinning, as they could if, like the Brazilian, they were reasonably clear and transparent with natural faces showing. However, a small amount of good material was found and the speaker understood that at least one important wireless transmitter in this country had its wavelength controlled by means of a plate of Uganda quartz.

Mr. Bisset, in reply, thanked the speakers for their interest in Uganda, and for their kind remarks concerning himself. He would like to assure Dr. Way that his earlier geophysical work on the argentiferous gold-bearing reefs of Busia did prove of value in the end. As regards the application of geophysics to minerals in Ruwenzori, this had indeed been done at one stage of the proceedings, but he doubted if it had added anything to their previous knowledge. He thought, however, that a search for minerals under the laterite might well be carried out by this means, but little opportunity had hitherto been found for doing this on account of the demands made upon the available geophysical outfit for the immediate search for water, and because of its loan to the Army for war purposes in Kenya. Shortage of staff, too, made things difficult. Such a search as that envisaged had therefore to remain a matter to be attended to when circumstances permitted.

The lecturer said that he had had an opportunity when in Tanganyika of seeing several of the "sand rivers" to which Sir Edmund Teale referred. These were definitely sand-filled trenches in black clay, whereas such of the Uganda "rivers" as were investigated appeared not so much to be bottomed in clay as in more pervious materials, e.g. sandy clays. In one case, augering to

20 ft. failed to find a satisfactory bottom. Little opportunity had since been afforded for carrying out further research, but it might well be that the conditions in Uganda were different from those to which Sir Edmund referred.

The exclusion of cattle from small dams was certainly a major problem, and it seemed almost impossible of solution. At first, it was thought that the Africans, being used to passing up water from their own wells would pass it up from the tanks, but such was not the case. The tendency for cattle to stampede towards the water was indeed difficult to control; fences erected were either torn up or burned down in the dry season. Attempts to plant prickly pear and other plants as live hedges were not successful. In the end, they just had to allow the cattle to make direct access to the water by means of a ramp. At the present time they had to confine their activities to obtaining more water rather than to improving its quality.

The search for piezo-electric quartz in Uganda was one of the most tantalising and disappointing pieces of work in which the Survey Department ever became involved. There was an urgent demand for such material, and, as the possibility of discovering new Empire sources of supply seemed to be confined to Uganda, and, however, as those crystals already found in the Protectorate were of superior quality, a very intensive search was made by the Department, and much assistance was given by prospectors in the area concerned. Finally, they were driven to the conclusion that the material just was not there in any quantity, and this was reported with regret.

This was one of the features of Uganda geology and mineral resources—there were so many small deposits of extremely interesting and valuable materials, but often it was a matter of very great difficulty to find any more.

Sir Harry Lindsay, K.C.I.E., C.B.E., Director of the Imperial Institute, at the close of the meeting, called for two votes of thanks—one for Mr. Bisset for giving a really admirable lecture and for answering the questions so fully and interestingly; the other for the Chairman, Sir Edmund Teale, for nobly stepping into the breach in the absence of Sir Bernard Bourdillon, and for presiding so genially and effectively over the proceedings. These were carried with acclamation, after which the audience was invited to inspect a comprehensive collection of publications, maps and minerals of Uganda in the Pavilion.

OBITUARIES

Dr. John Downie Falconer and Dr. John Parkinson.—Within four months the Imperial Institute has lost two of its oldest friends and associates—John Downie Falconer, M.A., D.Sc., F.R.S.E., F.G.S., F.R.G.S., and John Parkinson, M.A., Sc.D., M.Inst.M.M., F.G.S., F.R.G.S., for from 1903 until 1906 Dr. Parkinson was in charge of the Mineral Survey of Southern Nigeria which was conducted under the supervision of the Director of the Imperial Institute, while from 1904 until 1909 Dr. Falconer was in charge of that of Northern Nigeria.

John Parkinson was born in London in 1872 and was educated at University College, London, and St. John's College, Cambridge, where he obtained his doctorate of science. After some research on variations of mollusca, the value of which was recognised by the British Association in 1897, he lectured in geology and geography at Harrow from 1902 to 1903. He was then appointed Principal of the Imperial Institute Mineral Survey of Southern Rhodesia and was so employed until 1906. After a year spent as geologist to the Liberian Development Company he was engaged in economic geology, largely in connection with the search for petroleum in West Africa, Kenya, Trinidad (where he was Chief of the Geological Staff), Venezuela (also as Chief of the Geological Staff), India, Burma and Tanganyika Territory.

In 1927 he was chosen as leader of the British Museum's (Natural History) Expedition to East Africa to investigate the skeletons of dinosaurs *in situ*. After this work was finished he was appointed in 1931 geologist to the water supply development scheme and remained there in 1932.

He subsequently visited Ceylon and Canada in connection with his geological studies. In 1940 he returned to Kenya temporarily attached to the Geological Department. He later joined the staff of the Ministry of Economic Warfare but in 1942 ill health compelled him to retire. In addition to *The Dinosaurs in East Africa* published in 1930, he was the author of many scientific papers and he wrote two novels. In 1915 he was awarded the Lyell Fund by the Geological Society.

He died in London on July 19 at the age of 75.

John Downie Falconer was born in Midlothian in 1876 and was educated at the Universities of Glasgow and Edinburgh, receiving his M.A. (Glasgow) in 1898 and his D.Sc. (Edin.) in 1906. From 1901 to 1904 he was assistant to Professor James Geikie and in the latter year was appointed Principal of the Imperial Institute Mineral Survey of Northern Nigeria, retaining this appointment until 1909. From 1911 to 1916 he was a lecturer in geography at Glasgow University, returning to Nigeria in 1916 as a temporary Assistant District Officer, but in 1918 he was appointed the first Director of the Geological Survey and held this post until 1927.

From 1928 to 1934 he was geologist to the Republic of Uruguay.

Among his many publications, including scientific papers and official bulletins and lighter works on travel in Nigeria and Uruguay, the best known is his *Geology and Mineral Resources of Northern Nigeria*. Whilst Director of the Geological Survey of Nigeria he was responsible for the earlier issues of the bulletins and the accompanying geological maps which were of special interest with reference to the tin resources of the Colony.

In 1920 he was awarded the Lyell Fund by the Geological Society and from 1927-1929 he served on the Council of the Society.

His death on April 16, at Hounslow, came as a shock to his many friends and colleagues especially as he was in apparent good health just a month before at the annual meeting of the Geological Society.

Sir Thomas Henry Holland, K.C.S.I., K.C.I.E., F.R.S.—It is with deep regret that we record the death on May 15 of Sir Thomas Henry Holland, aged 78 years, one of the outstanding geologists of our age. His pre-eminence was recognised by the fact he was President-Designate of the Eighteenth Session of the International Geological Congress to be held in this country in 1948, and he was also President of the Organising Committee of this Congress.

Thomas Henry Holland was born at Helston, Cornwall, in 1868, and at the age of 16 won a national scholarship to the Royal College of Science, London. During his three years' study there he won the Murchison Medal and Prize, took the full diploma of Associate in the first class and was appointed assistant to the Professor of Geology, Professor Judd. In 1889 he gained a Berkeley Fellowship to Owen's College, Manchester, but during his first year there he was appointed an Assistant Superintendent in the Geological Survey of India. He at once obtained permission to make a planned tour in the United States, Canada, China and Japan before joining the Survey, which he did in 1890.

He was made Curator of the Geological Museum and Laboratory on his arrival, and although he held this post for some years, he made many excursions into the field and was also available at Headquarters for emergency enquiries as they arose. He soon showed that he possessed unusual ability and was appointed Director in 1903. He immediately set to work to reorganise his department and to raise its status both with the Government and the business public. He obtained an increase of staff and better conditions of service and a full review of the mineral industries of the country was soon completed. He secured for the Survey the duty of collecting and collating the statistics of mineral production in India; he resuscitated the annual reviews published in the *Records of the Geological Survey of India*; instituted the well-known quinquennial reviews of mineral production; and ensured that fuller use was made of his department for advising the Central

and Provincial Governments on the granting of concessions for prospecting and mining throughout British India. In addition the output of scientific publications was doubled. He also was largely responsible for the creation of a Chair of Geology at the Presidency College, Calcutta, of which he was the first occupant.

In 1908 his outstanding services to science in India were recognised by the award of the K.C.I.E., but in 1909 he resigned his directorship on accepting the Chair of Geology at Manchester University. He was, however, soon to return to India, for in 1916 he was appointed President of a Commission on Industries in India, later to become the Indian Munitions Board with Holland as President. In 1918 he was created a K.C.S.I. for his share in India's war effort. With the end of the war the Munitions Board became, in 1919, the Department of Munitions and Industries and Holland became a member of the Viceroy's Executive Council. In 1921 he was also appointed Member for Commerce, so that he held two portfolios simultaneously, but at the end of that year a difference with the Viceroy led to his resignation.

In 1922 he succeeded Sir Alfred Keogh as Rector of the Imperial College of Science and Technology, London, and in 1929 he was appointed Principal and Vice-Chancellor of the University of Edinburgh, an office he held until his retirement in 1944 at the age of 76.

As a result of his outstanding energy and organising ability, Sir Thomas Holland was prominent during his long active career in the administration of scientific and technical societies and institutions, and although much of his time was so occupied he was responsible for the publication of many outstanding scientific works. Inevitably, Sir Thomas Holland was the recipient of many honours, in addition to the K.C.I.E. and K.C.S.I. already mentioned.

Sir Thomas Holland was for many years associated with the Imperial Institute. From 1910 to 1916 he was a member of the Advisory Committee and from 1928 until 1944, he was a member of the Advisory Council on Mineral Resources. At the time of his death he was still a member of the Mining Law Technical Committee.

G. H. Tipper.—It is with deep regret that we record the death on April 23, 1947, at Cambridge, of George Howlett Tipper, M.A. (Cantab.), M.Inst.M.M., F.G.S. Born in Kendal in 1881, he was educated at Kendal Grammar School and Clare College, Cambridge. In 1903 he joined the Indian Geological Survey as Assistant Superintendent and remained in this service until his retirement in 1929. In addition to considerable time spent in the field in India and Burma and in the Andaman and Nicobar Islands, Baluchistan, Persia and Chitral, he served both as Palaeontologist and as Curator of the Geological Museum in Calcutta. In 1915 he was commissioned in the Indian Army Reserve of Officers and served in Egypt, the Libyan Desert and, for a short time, in France, until his recall in 1917 to help with the production of mica in India.

He had already specialised in this mineral, but from this time forward his interest in it was greatly increased and he became, by practice, an expert in its mining and preparation for industry.

In 1928 Mr. Tipper returned home on leave pending retirement and was appointed Mineral Adviser to the High Commissioner for India, an appointment he held until his retirement on account of ill-health in 1946. He married Dr. C. F. Elam, the well-known metallurgist, and settled in Cambridge, where he intended to work on fossils which he had collected in Chitral.

On the outbreak of war in 1939 he was seconded for a short period to the Ministry of Economic Warfare and in 1940 was appointed Adviser on Mica to the Ministry of Supply and visited Washington and India on their behalf. In 1941 he became Minerals Adviser to the British Raw Materials Mission in Washington and was especially concerned in the organisation of supplies of mica on both sides of the Atlantic, representing both Great Britain and the Government of India in this matter. In 1943 he was attached to the United States Mica Mission that visited this country, returning here in 1944 as Minerals Adviser to the Ministry of Production, chiefly on mica. In 1945 he was placed in charge of the new Directorate of Mica under the Board of Trade, and held this appointment until ill-health led to his retirement in 1946, but he continued in an advisory capacity until his death.

Mr. Tipper's association with the Imperial Institute dates from 1928 when he was appointed Minerals Adviser to the High Commissioner for India and attended meetings of the Advisory Council on Minerals as the latter's representative. Subsequently he represented the High Commissioner on the Mineral Consultative Committees and was Chairman of the Consultative Committee on Miscellaneous Minerals.

For nearly 20 years his services were placed at the Institute's disposal especially in matters affecting India's mineral industry generally and on questions relating to mica and non-metallic minerals in particular. He took a great interest in the work of the Mineral Resources Department, and his helpful co-operation and wise advice were much appreciated and will be greatly missed.

ABSTRACTS AND NOTES

Potash Deposits in Saskatchewan.—The Imperial Institute has received through the courtesy of the Office of the Canadian High Commissioner in London, a copy of a preliminary report on "Saskatchewan Potash Occurrences" by A. J. Williams, of the Department of Natural Resources and Industrial Development, Saskatchewan. Following the discovery at Vera in June 1946 of probably the first indication of potash beds of commercial grade in the Province, the Department of Natural Resources, aided by the

University of Saskatchewan and the Federal Department of Mines and Resources, undertook a detailed investigation into the feasibility of producing and marketing domestic potash. So far, the data acquired have not been sufficient to enable a definite decision to be made on this subject, but it is thought that the Vera deposit may rank with some of the best on the American continent.

Particulars concerning the Saskatchewan potash deposits in the six deep test wells where the material has been proved are given in the following table, the associated rocks being almost entirely Silurian salt beds.

Well.	Location.	Depth range of salt zone. (*Ft.*)	Thickness of potash-rich section of salt zone. (*Ft.*)	Weighted average K_2O content of potash section. (*Per cent.*)	Potash minerals.
Verbata No. 2	Vera, 10 miles N.W. of Unity	3,459–3,894	11	21·6	Sylvinite
Ogema No. 1	50 miles W. of Weyburn	7,317–7,598	90	8·1	Sylvinite, carnallite
Radville No. 1	30 miles W.S.W. of Weyburn	7,590–7,842	33·7	9·2	Sylvinite
Davidson No. 1	Midway between Moose Jaw and Saskatoon	4,352–5,000 (lowest of three zones)	Not yet known	Not yet known	Sylvite
Davidson No. 2	Midway between Moose Jaw and Saskatoon	4,505–?4,577 (hole abandoned)	Not yet known	Not yet known	Sylvinite
Pennant No. 1	20 miles N.W. of Swift Current	5,805–5,962	Not yet known	Not yet known	Sylvinite

As regards the combined thickness and grade of the potash beds, the first three deposits, which have been analysed in some detail, compare favourably with those now supplying the world market for potash. By way of comparison, the following figures are given: the Stassfurt deposits of Germany, over 300 ft. thick, contain 7 to 12 per cent. K_2O; the Alsace (Mulhouse) deposits of France occur in two beds, the upper 3 ft. thick and with 22 to 25 per cent. K_2O, the lower $7\frac{1}{2}$ to 16 ft. thick and with 15 to 20 per cent. K_2O; the ten beds in the Carlsbad area, New Mexico, total 36 ft. in thickness and contain 25·6 per cent. K_2O; and the brine of Searles Lake, California, contains 3 per cent. K_2O.

The Saskatchewan deposits, however, are found at much greater depths than are the others mentioned above (Stassfurt, 1,000-1,400 ft.; Alsace, over 1,500 ft. and over 1,550 ft. respectively; Carlsbad, 1,200-1,400 ft.). Indeed, the Vera deposit is the only one in which it is feasible to mine by shaft methods, and in this connection the proved availability in that area of natural gas for fuel purposes is an important consideration. The other deposits would require solution mining with subsequent separation and refining of the potassium and sodium chlorides from the brine.

P. L. R.

Synthetic Mica and Empire Mica Producers.—As the countries of the British Empire are by far the most important source of naturally occurring mica, any developments relating either to synthetic mica

or to alternative substances are of direct consequence and concern to Empire producers, dealers and users of mica, as is also any progress made in mica processing.

The Imperial Institute decided therefore that one of its technical staff (Dr. E. R. Varley) should go with a team of experts which was sent to Germany by the British Intelligence Objectives Sub-Committee in order to ascertain what the Germans were doing in this subject during the war. As the Germans were cut off from the normal world sources of high-class mica, it was anticipated that there had been more activity in the Reich in the fields of synthetics, alternatives, and substitutes as well as with low-grade mica, than in the Allied countries, where mica, although classed as a strategic mineral, was never in such short supply as to encourage research on these aspects to anything like the same extent as in Germany. A good deal of interesting information on these topics was obtained by the B.I.O.S. team mentioned, and their findings have been incorporated in *B.I.O.S. Final Report No.* 785, Item Nos. 21 and 22 (London: H.M. Stationery Office, 1946, price 5*s.* 6*d.*), from which the following salient features have been extracted.

German deficiency in domestic sources of mica, which is a strategic commodity, necessitated measures being taken to meet the inevitable shortage which would result from being cut off from normal world supplies. Stockpiling before the war, confiscation of stocks in occupied countries, utilisation of low-grade mica from available sources, and control and conservation of uses were practised. Equipment normally incorporating mica was redesigned either to eliminate completely or to reduce materially the amount of mica required in them. Substitutes and alternatives were developed and used, notably glass flakes to replace mica splittings in part, and a resin-impregnated glass fibre sheet for commutator insulation. None of these substitutes is completely satisfactory and all are quite unusable in the high-grade uses to which mica is put, such as in radio and radar.

The only really outstanding advance in the mica industry in Germany was the research and development of synthetic mica which was undertaken, but the production of such mica had not reached full-scale operation by the end of the war. Pilot-plant production of synthetic mica in Germany had proceeded sufficiently far to indicate that, although even in full commercial operation it is likely to be more expensive than natural mica, a major industrial country could fulfil its essential requirements of high-grade condenser mica by production of the synthetic mineral.

No important advances were made in the fabrication of mica products, in the development of mica substitutes from bentonite or plastics, or in the production of synthetic mica by hydrothermal methods. With the exception of the successful work on synthetic mica, German practice in mica processing was inferior to technique and development in Britain or America.

The general conclusion, therefore, which is of importance to Empire producers of mica, is that although a good deal of progress has been made along alternative lines, the demand for the natural product will continue at a high level for many years to come.

E. R. V.

Sheet Mica in South Westland, New Zealand.—In April 1944, when overseas supplies of mica suddenly failed in New Zealand, attention was directed to local deposits on the Mataketake and Kinnaird Ranges. The results of these wartime efforts to increase the production of mica are described by H. W. Wellman, of the New Zealand Geological Survey, in the *New Zealand Journal of Science*, 1947, 28, 236-248. He succeeded in finding a workable deposit which was pegged out by the Radio Corporation of New Zealand in September, 1944. Mining continued for eleven months till VJ Day, August 15, 1945, when the urgent demand for mica ceased. During this period $1\frac{1}{2}$ tons of rough trimmed mica was produced.

The mica occurs as muscovite shoots in pegmatite sills in schist, and eight deposits are listed. The bulk of the muscovite produced came from an elevation of 1,800-1,900 ft. above sea-level. The first trimming was done by the miners during wet weather. The mica was then taken by horse to Mahitahi, and thence by car, rail and boat to Wellington. The final trimming was done by women in Wellington; this reduced the quantity by half so that about $\frac{3}{4}$ ton of trimmed sheet mica was utilised in the manufacture of radio condensers.

The proportion of mica discarded at the pits varied greatly in different deposits. At the first deposits worked it was as high as 70-90 per cent., but in the later workings nearer Blue River it rarely exceeded 70 per cent., and was usually about 50 per cent. The proportion of roughly trimmed mica to picked books also varied, probably averaging about 30 per cent.

The range in size of the trimmed mica was not accurately measured. The largest book found, 24 in. × 10 in. × 5 in., was trimmed to produce sheets 7 in. × 6 in. The lower limit was set by the consumers, who did not require material less than 2 in. × 1 in. The average size of the material produced was about 2 in. × 3 in.

The author concludes that South Westland can supply all the mica needed by New Zealand, but the cost will be prohibitive unless the access to the deposits is improved and machinery can offset the high labour costs. The difficulty of access was probably the greatest adverse factor, the last part of the journey to the mica deposits being by pack-horse track.

A. W. G.

Mineral Production of Tanganyika.—The table on p. 188 showing the production of minerals of Tanganyika Territory for the period 1939 to 1946 has been supplied by the Chief Inspector of Mines,

TANGANYIKA TERRITORY—MINERAL PRODUCTION, 1939-1946

		1939.	1940.	1941.	1942.	1943.	1944.	1945.	1946.
Building materials	*cu. ft.*	718,598	335,000	276,051	799,769	1,328,791	2,676,954	1,877,677	2,275,895
Corundum	*long tons*	—	—	—	—	6·44	—	—	—
Diamonds	*carats*	3,445	6,221	29,052	40,327	52,998	90,067	115,620	119,446
Gold (refined)	*troy oz.*	125,784	144,265	142,685	106,835	72,723	55,148	50,659	48,428
Kaolin	*long tons*	—	—	—	37	113	219	296	180
Lead ore	,,	—	10	—	20	—	10	—	5
Mica—Block and sheet	,,	30·6	9·5	4·75	12·69	27·3	125·48	96·19	72·29
Ground	,,	5	—	—	—	—	—	—	—
Waste	,,	—	—	—	—	—	—	150	265
Phosphates	,,	132	8	32	25	263	28	9	275
Salt	,,	9,623	9,355	8,355	9,183	10,399	11,037	9,395	12,808
Silver (refined)	*troy oz.*	27,336	36,431	39,624	26,599	18,705	17,120	21,594	21,179
Talc	*long tons*	5	6	—	—	—	—	—	—
Tin ore	,,	311	353	335	265	218	170	187	181
Tungsten ore	,,	0·3	2	1	2·2	3·075	—	—	—
Vermiculite	,,	—	—	—	—	—	—	—	50

PALESTINE—MINERAL PRODUCTION, 1940-1946
(*Long tons*)

	1940.	1941.	1942.	1943.	1944.	1945.	1946.
Gypsum	4,333	4,765	7,990	5,895	7,311	7,423	14,283
Plaster of Paris	233	254	1,078	206	264	536	974
Salt—Rock	590	567	1,856	1,793	1,162	2,110	1,546
Sea	9,787	10,792	10,536	17,671	18,754	16,092	22,797
Sulphur	1,358	3,365	713	—	—	—	—
Potash (80 per cent. KCl)	87,556	100,002	102,591	92,268	103,391	92,146	89,141
Liquid Bromine	920	519	986	800	71	77	49
Felspar	—	—	—	84	64	36	52
Barytes	—	—	—	—	—	23	3

Dar es Salaam, from which it will be seen that, with the exception of the metallic minerals, e.g. gold, silver and tin, all other minerals showed increases, the most notable of which was for diamonds, viz., from 3,445 carats in 1939 to 119,446 in 1946.

W. B.

Mineral Production of Palestine.—The table on p. 189 showing the production of minerals in Palestine for the period 1940-1946 has been forwarded by the Government Geologist, Public Works Department, Jerusalem, from which it will be seen that the output of potash (80 per cent. KCl) reached a peak of 103,391 tons in 1944. Gypsum, plaster of paris and salt all showed increases over the 1940 production. There was a notable falling off in the output of liquid bromine during the period under review, viz., from 920 tons in 1940 to 49 tons in 1946. Two new items, felspar and barytes, have been recorded in later years, while the production of sulphur ceased in 1942.

W. B.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

DICTIONARY OF GEMS AND GEMOLOGY. By Robert M. Shipley. Second Edition, Second Printing. Pp. xi + 258, $7\frac{1}{2} \times 5\frac{1}{4}$. (541 South Alexandria Avenue, Los Angeles 5, California: Gemological Institute of America, 1946.) Price $5.50.

This dictionary appeared first in serial form in an American gemmological periodical and originally consisted of some 1,700 definitions and pronunciations of terms used in the gem and allied industries. In its new form as a separate book it has been expanded to include over 4,000 English and foreign terms and abbreviations. Though this is a work of reference rather than a text-book, it has, nevertheless, the merit common to all good glossaries and dictionaries, that one can keep dipping into it with interest and profit.

References in this work to terms used in the diamond industry are notably few in number, but this is part of a definite policy on the part of the publishers who are to produce a separate glossary on diamonds.

The main body of the work is concerned with the subject indicated in the title, but it also contains one or two other features of interest and use to gemmologists, for instance, brief biographies of some of the more outstanding gemmologists in the world, and the names, descriptions and addresses of the principal museums, laboratories, organisations and periodicals concerned with gemstones and gemmology.

E. R. V.

ELEMENTS OF MINING. By George J. Young. Fourth Edition. Pp. xvi + 755, 9 × 6. (New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1946.) Price 32*s*. 6*d*.

The previous edition of this well-known text-book on general mining practice appeared in 1932 and was duly noticed in this BULLETIN (1933, **31**, 318). During the period that has since elapsed, the mining industries have been called upon to give of their utmost, and there has been an inevitable and serious drain upon mineral reserves as a direct outcome of the war. The future of mining would therefore appear to lie largely in the direction of prospecting, exploration, and development of new discoveries, and in the ability of the mining engineer to obtain a knowledge of the backlog of mining experience and to use it to the full.

It is with this object in view that the author has carefully revised his text, keeping the general format unchanged, but deleting here and expanding there. The section on explosives, to quote but one example, has been largely rewritten in order to give an adequate account of the great developments made in this subject since the previous edition was issued. No mention, however, is made in the section on drilling for blasting purposes of the important development in the use of carbide-tipped bits for extremely hard and tough rocks.

Though the quality of the materials used in the manufacture of this book is inferior to that of former editions, being governed by continued post-war shortages in the United States, the work is still well produced, and will undoubtedly maintain its position as one of the standard treatises on the elements of mining, especially with reference to American practice.

E. H. B.

REPORTS ON FUEL ECONOMY SINCE 1939: French National Committee, pp. 28, $9\frac{1}{2} \times 6\frac{1}{4}$, price 1*s*. 6*d*.; Irish Committee, pp. 8, $9\frac{1}{2} \times 6\frac{1}{4}$, price 6*d*. (London: Central Office of the World Power Conference, 1947.)

These reports are drawn up on lines similar to those of the British, United States, Danish, Netherlands and Swedish National Committees of the World Power Conference, which were reviewed in the previous number of this BULLETIN (1947, **45**, 82, 83).

The report of the French National Committee is published separately in French and English, and consists in the main of four parts, three of which consider in turn the position in France with regard to electric power, coal and carburants. They are further divided into many sub-sections giving details concerning different aspects of these subjects. The manner in which the war utterly disrupted normal operating conditions for the extraction of solid and liquid fuels, the generation of hydro-electric power, the

manufacture of synthetic liquid carburants, and similar processes, is clearly illustrated in the report, and the severity of the disorganisation may be gathered, for instance, from the fact that the activity of the petroleum refineries during the period 1941-44 averaged only 0·11 per cent. of the 1938 figure. Owing to these war difficulties, thermal power and hydro-electric stations had to be overloaded, a considerable reduction occurred in coal output, and it became necessary to use various substitutes for liquid carburants. Among the future prospects to which the report refers are the construction of great hydro-electric works and a thorough reorganisation of the coal industry. Fuel economy in French overseas territory is dealt with in the fourth section of the report.

The report of the Irish Committee, which covers both Northern Ireland and Eire, brings out the drastic effect upon the latter of the big reduction in its coal imports from Great Britain and of the deterioration in quality of the coal that was obtained. Steps were taken by the Government to ensure the maximum production of turf, and the installation of several peat fuel generating stations on turf bogs has been arranged for the future. The report gives very little mention of liquid fuels.

P. L. R.

WORLD POWER CONFERENCE ANNUAL REPORT, 1946. Pp. 15, 10 × 8. (London: Central Office of the World Power Conference, 1947.)

This Annual Report, the first to be published since that for 1939, contains information on the post-war activities, the financial position and the publications of the World Power Conference. Mention is made of the intention to issue during 1947 *Statistical Year-book No.* 4, providing annual statistics for the period 1936-45 inclusive. A section of the report deals with the resumed activities and future plans of the Conference's International Commission on Large Dams, which has decided to hold its Third Congress at Stockholm in 1948.

P. L. R

POWDER METALLURGY. By Dr. Henry H. Hausner, E.E. Pp. vii + 307, $8\frac{1}{2} \times 5\frac{1}{2}$. (Brooklyn, N.Y.: Chemical Publishing Co., Inc., 1947.) Price $7.00.

Powder metallurgy is one of the most recently developed branches of metallurgy and, as so often happens in a new technique, the theory of the subject is still in its initial stages and far behind practical experience. The purpose of the book under notice is, we are told, to give the principles of powder metallurgy in the form of tables and graphs and to show the relationship between the physical properties of the metallic compact and the variables of the powder metallurgical process.

The book is divided into three parts: general data on powder

metallurgy, graphs and tables on powder metallurgical methods, and lastly a bibliography.

A glossary of terms is a useful addition usually found in an appendix, but in the present instance it forms the opening chapter to Part I. This is followed by four short chapters on the principles of the subject, methods of manufacturing metal powders (three pages only), commercially available metal powders and their applications, and comparison between the physical properties of sintered metals and those of the equivalent fused materials.

By means of an extensive collection of tabular and graphical matter, the author sets out in Part II the physical and engineering properties of the powder metallurgy product as functions of the composition, powder particle size, compacting pressure, sintering temperature, sintering time, atmosphere of the heat treatment of subsequent working, and other factors of processing.

Part III consists of a 130-page bibliography containing 1,064 references. These are arranged in chronological order and are supplemented by a subject index, an author index, and a list of abbreviations of periodicals used in the bibliography.

A. W. G.

METALLURGICAL MATERIALS, ALLOYS AND MANUFACTURING PROCESSES. By V. N. Wood, A.M.I.B.F. Pp. xii + 340, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1946.) Price 25*s*.

This is a comprehensive but concise handbook intended for engineering students taking courses in metallurgy, and is written by one well qualified for the task, the author being a metallurgist with wide practical experience both in industry and in the lecture room. The greater part of the book is devoted to iron and steel, including methods of manufacture, testing, metallography, heat treatment and mechanical working, with chapters on carbon and alloy steels and cast irons. Copper, aluminium and magnesium and their alloys, and the white metal alloys are treated adequately but more briefly, without including methods of manufacture. A chapter of miscellanies includes welding, galvanising (but not tinning or other methods of plating), centrifugal castings and chilled castings, etc.

The book is profusely illustrated with very informative photographs and diagrams. In points of detail, metallurgical experts and specialists might find much to criticise in this handbook, but the students and engineers for whom it was written will doubtless find it a most useful book.

T. D.

TINPLATE. By W. E. Hoare, B.Sc. (Eng.), A.I.P.E., and E. S. Hedges, M.Sc., Ph.D., D.Sc., A.R.I.C. Pp. viii + 292, 10×8. (London: Edward Arnold & Co., 1946.) Price 40*s*.

Though the tinplate industry has expanded considerably during

recent years, consuming perhaps between 3 and 4 million tons of steel and 60,000 tons of tin annually, there has hitherto been no authoritative English text devoted entirely to the subject. The present work is accordingly designed to supply such a text on tinplate and to give a balanced account of its history, manufacture, uses, properties, structure, testing methods, and corrosion resistance. Tinplate fabrication, however, is not treated except in so far as the effects of deformation on structure and corrosion resistance are discussed, as it is believed that this subject is worthy of a book in itself.

Both authors are distinguished members of the Tin Research Institute, and are well qualified for the task they set out to accomplish. The result is an excellently produced book consisting of 12 chapters each with its own bibliography, the whole being illustrated by 150 diagrams and half-tone plates, six of which are folding plates. The work concludes with a 20-page statistical appendix compiled by G. H. M. Farley, also of the Tin Research Institute, giving details over periods of many years of world production, prices, consumption, etc., of tinplate and related materials.

E. H. B.

Chemical Facts and Figures. Compiled by M. F. Crass, Jun. Second Edition. Pp. ii + 401, $10\frac{1}{2} \times 8$. (Washington: Manufacturing Chemists' Association of the United States, 1946.)

Chemical Facts and Figures is an apt title for this publication, which, as its cover states, contains "useful information and statistics relating to the Chemical and Allied Products Industries," for the United States. The period covered is 1940 to 1945 and in some cases for the first six months of 1946 and very comprehensive tables are given showing production, sales, consumption, foreign trade and prices for nearly every organic and inorganic raw material and its by-products. Practically all this information has been compiled from official sources and its usefulness is enhanced by the fact that it publishes in one volume statistics which would otherwise have to be obtained from many other publications. Because of this the book can be recommended to all those wishing to have complete statistical information of the American Chemical Industry at their fingertips.

W. B.

BOOKS RECEIVED FOR REVIEW

Reports on Fuel Economy Since 1939: Finnish National Committee, pp. 4, $9\frac{1}{2} \times 6\frac{1}{4}$, price 4*d.*; Comité Algérien (printed in French), pp. 15, $9\frac{1}{2} \times 6\frac{1}{4}$, price 1*s.*; Belgian National Committee, pp. 7, $9\frac{1}{2} \times 6$, price 6*d.*; Norwegian National Committee, pp. 12, $9\frac{1}{2} \times 6$, price 6*d.*; Portuguese National Committee, pp. 8, $9\frac{1}{2} \times 6$, price 6*d.*; Swiss National Committee, pp. 20, $9\frac{1}{2} \times 6$,

price 1s.; Hungary, by Professor L. de Verebélÿ and others, pp. 5, $9\frac{1}{2} \times 6\frac{1}{4}$, price 6*d*. (London: Central Office of the World Power Conference, 1947.)

FUEL ECONOMY CONFERENCE OF THE WORLD POWER CONFERENCE, THE HAGUE, 1947: Nuclear Energy for Power Production, by Ward F. Davidson, United States National Committee (Section A 6, Paper No. 1), pp. 11, $9\frac{1}{2} \times 6$; L'Energie Atomique en France, by L. Kowarski, Comité National Français (Section A 6, Paper No. 2), pp. 5, $9\frac{1}{2} \times 6$; The Application of Nuclear Energy to the Generation of Heat and Power, by J. D. Cockcroft, C.B.E., Ph.D., F.R.S., British National Committee (Section A 6, Paper No. 3), pp. 5, $9\frac{1}{2} \times 6$. (London: Central Office of the World Power Conference, 1947.)

PETROLEUM PRODUCTION: Vol. III, OIL PRODUCTION BY WATER. By Park J. Jones. Pp. vii + 271, 9×6. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Limited, 1947.) Price 30*s*.

IGNEOUS MINERALS AND ROCKS. By Ernest E. Wahlstrom. Pp. ix + 367, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited, 1947.) Price $5.50 (33*s*.).

PETROGRAPHIC MICRO-TECHNIQUE. By A. V. Weatherhead, F.G.S., F.R.M.S., A.R.P.S. Pp. x + 98, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Arthur Barron Ltd., 1947.) Price 12*s*. 6*d*.

THE SAMPLING AND ASSAY OF THE PRECIOUS METALS. By Ernest A. Smith, Assoc. R.S.M. Second Edition, revised. Pp. xvi + 505, $8\frac{3}{4} \times 6$. (London: Charles Griffin and Company, Limited, 1947.) Price 42*s*.

STRATEGIC MINERALS. By John B. DeMille. Pp. viii + 626, 9×6. (New York and London: McGraw-Hill Book Company, Inc., 1947.) Price 37*s*. 6*d*.

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Compiled by E. R. VARLEY, Ph.D., B.Sc., D.I.C., A.Inst.M.M.

Comprising the more important reports, articles, etc., contained in publications received in the Library of the Imperial Institute during the three months February-April 1947.

The publications issued by the Governments of the Colonies and Protectorates can be obtained from or through the Crown Agents for the Colonies, 4 *Millbank, Westminster, S.W.*1. *Applications for Dominion and Government publications may be made to the Offices of the High Commissioners or Agents-General in London.*

Publications of the U.S. Bureau of Mines, Bureau of Standards, and Geological Survey are obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, *D.C.*

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EMPIRE EDUCATIONAL FACILITIES

EXHIBITION GALLERIES, LANTERN SLIDES, FILMS, LECTURES, Etc.

EMPIRE SERVICE AT THE IMPERIAL INSTITUTE[1]

By SIR HARRY LINDSAY, K.C.I.E., C.B.E.,
Director of the Imperial Institute

THE Imperial Institute was founded in 1887 as a memorial of the Golden Jubilee of Queen Victoria at a cost of £400,000. This sum, which was spent partly on the building and partly on its endowment, had been contributed by many interests in many countries of the Empire, Home and Overseas, and represented private as well as official gifts. The building was completed in 1893 and was opened that year by Queen Victoria herself. The objects of the foundation as described in the original charter and modified by the Imperial Act of 1925, may be summarised as follows :

In the first place, Scientific and Technical Objectives. A staff of between 30 and 40 scientists handles inquiries received from all countries of the Commonwealth. Many of these inquiries are accompanied by actual specimens of the economic products about which advice or information is sought. In preparing their replies, members of the staff rely partly on their own work in the Institute Laboratories, partly on the technical reports, books and other publications in the Institute's Library, and partly on the information recorded in the Card Index system or in current correspondence. They are also assisted by two Advisory Councils and fifteen Consultative Committees comprising Government officials, business men and technical experts. The two Councils deal with the two groups of subjects, Plant and Animal Products and Mineral Resources, with which the two Scientific Departments of the Institute are respectively concerned. The fifteen Committees are grouped under one or other of the two Councils and are responsible for advising on important classes of raw materials such as Vegetable Fibres, Oils and Oilseeds, Hides and Skins, Essential Oils, Insecticides, Silk, and so on ; and on the Minerals side Precious Metals, Base Metals, Iron and Ferro-Alloys, Chemical Industries, Mining Law, etc.

On its scientific side, the Institute is thus organised as a Technical Information Bureau. It is well equipped both in its Laboratories

[1] Summary of an Address given to the Worthing Branch of the Overseas League, on Saturday, 15th February, 1947.

and in its Intelligence Offices to furnish all Empire inquirers with technical information bearing on any Empire raw material—methods of production or mining, processing, transportation, uses and markets. It is not merely a Bureau which collects and disseminates published information; it also collects unpublished information from many sources, official and unofficial, and uses it with discrimination and strict observance of the confidential character of some of the information received, in the interests of Empire development; and again much of the work is original, based on investigations conducted at the Institute on actual specimens received in its Laboratories. These are services of no little importance to the Commonwealth for they are invariably and effectively directed to stimulate the development of Empire resources and the demands for its economic products.

The second of the two main functions of the Institute may best be described under the heading "Empire Education"; and it is this function with which I have been asked by Sir John Hope Simpson, your President, to deal more particularly this afternoon. This part of my talk I will divide into three parts. First: How is the Institute organised to impart instruction on Empire matters? Secondly: Whom do we instruct? Thirdly: What is the story which we try to get across?

First, then—How are we organised to carry out these duties? We have four Exhibition Galleries which lie behind the Institute in a great rectangle and run east, west, south and north; their total aggregate length is roughly one-third of a mile. Each Gallery is divided into Empire Courts so arranged that the various countries represented follow each other in geographical sequence. From India, Burma, Ceylon, and Aden, in the East Gallery, we pass to Somaliland, the Sudan, East, South and West Africa and the Mediterranean Colonies in the North Gallery. Canada occupies the whole of the West Gallery; and the South Gallery is given up to Newfoundland and the West Indies, the Pacific, New Zealand, Australia, Sarawak, Hong Kong and Malaya, and so back to India again in the East Gallery. Each Court tells, by means of dioramas, photographs, models and specimens, the story of the Empire country represented, its chief industries, its scenery and the life of the people. Our guide lecturers conduct parties of visitors round the Galleries and explain the exhibits in the various Courts. We have an Exhibition Hall and an Art Gallery and a Central Stand where our own publications are displayed and sold and where literature of more general interest about Empire life and travel is available. From the Central Stand also are organised our issues of picture postcards of the chief industries and views of the Empire and of specimens of Empire products in demand by schools. Our Cinema shows regular programmes of Empire films and our Empire Film Library circulates such films to schools and societies throughout the length and breadth of the United Kingdom.

Of course, we regard 1946 as the first year approximating to peace conditions. We cannot say that we have yet brought the attendances in our Galleries and Cinema up to the popularity which they attained in the year 1938, when we registered approximately half a million visitors. Nevertheless we have made a good start with about one-fifth of that number—over 100,000; and the interesting point is that they include 536 school parties—a figure which shows how great is the support given to us by London and suburban schools. During practically every one of our working days, Mondays to Saturdays, we have at least one or two school parties in the Galleries, sometimes as many as two or three or even five. On such occasions our Cinema, with a capacity of 375, is practically full, counting both children and adults.

With regard to film circulation, during 1946, apart from the daily display of Empire films in our Cinema, we circulated 28,000 Empire films on loan to schools throughout the length and breadth of the United Kingdom. Thus on average about fifty schools see our Empire films every day during term time, with, of course, some special sessions during the holidays. Although the Empire Film Library is part of the equipment of the Institute, it is included for convenience of administration in the Central Film Library, organised by the Central Office of Information, on whose behalf we act as agents in the circulation of the films.

In addition to the films, we maintain an Empire Lantern Slides and Film Strip Library from which we issued 1,254 sets (i.e. separate collections of slides or rolls of film-strip) during the year. Some of these collections are accompanied by lecture notes for the convenience of school teachers; some are loaned to our Empire Lecturers when they visit schools. The total number of showings of Empire slides or film-strips during the year was 3,400, which means aggregate audiences of between 150 and 200 times that figure. Every year we do our utmost to bring this Library up to date with the help of Dominion and Colonial Officers with whom we naturally maintain close contact. It is, of course, very important to keep this work up to date, for old slides are worse than useless and seriously detract from the value of our Empire efforts.

I now turn to another of our activities to which we attach considerable importance, namely our Empire Lectures Scheme. In pre-war years the Institute used to organise lectures on Empire countries or subjects in our Cinema Hall, but during the war years this service was impossible. So we turned instead to the organisation of a panel of Empire Lecturers whom we sent out to give lectures in schools at the request of the Head Teachers or Local Education Authorities. During each successive year since 1940 when the Scheme started, the popularity of this service has increased, as shown by the returns of lectures given—so that in 1946 we gave over 4,000 lectures about the Overseas Empire. This is a tremendously important national, or I should say imperial,

service, for it means that the realities and the responsibilities of our Empire citizenship are brought home to the younger generation in a vivid and realistic way. In this matter we work in very close harmony with the educational authorities and head teachers, who recognise that we are not trying to compete with them in any sort of scholastic work, but rather to present a new view of the Empire, its life, scenery, industries, and especially its human aspects, through the minds of Lecturers who are themselves either nationals of the countries described or else have had long personal experience in those countries. In other words, if there is a science of Empire history or geography which the school teacher is best qualified to put across, there is also an art of Empire life and Empire geography which can only be revealed by a visitor from those countries. Throughout we work in very close touch with the Ministry of Education, and we are beginning a campaign with the Training Colleges so that the school teachers of the future may gain vivid and early impressions of the services which the Institute is able to render to the schools.

I have said enough I hope to show you that the principal services which we render to schools in the domain of Empire education are those grouped under the heading of "visual instruction," or, as it is more frequently called now, "visual aids." I need not do more than refer briefly to the other visual aids with which we are equipped, namely Empire leaflets, Empire publications of all sorts, including picture postcards and posters; and what we call "School Specimens," that is to say, small samples of Empire products which are not commonly available in the shops of this country and which help the school child to visualise the actual products with which he or she is dealing in the course of ordinary school lessons. What does vanilla look like? or cotton? or ground nuts? or some of the rarer minerals? If we can help the school museum to acquire samples of these and other Empire commodities we are helping to make Empire products and resources a great deal more real.

I now turn from the equipment of the Institute with visual aids to Empire education to the second question which I have to raise, namely, "Whom do we instruct?" To some extent I have answered this question already, showing you the large proportion of school children who visit our Galleries and Cinema and the fact that our circulation of films and lantern slides and other visual aids and the organisation of our Empire Lecturers' panel are all chiefly directed towards the schools of this country—not to public or private schools, for the unofficial Empire Societies such as the Overseas League, the Royal Empire Society and the Victoria League, cater chiefly for the public and private schools. Our particular concern is with the thousands of grant-aided schools in England and Wales. We hope to be able to advance into Scotland; but at present we have our hands more than full as you can well imagine!

So our approach is at present concentrated on the school children ; and here let me say a few words on the difficulties and the triumphs of this approach. Whether it be by means of our Galleries, Cinema, film shows, lectures, or whatever the approach, there is one cardinal word which we keep very prominently in our own minds in organising these Empire services—Interest—Interest—Interest. That is our first and greatest objective. A small boy once remarked that " when a man is wrapped up in himself he makes a very small parcel." What we are trying to do, then, is to persuade the child to open its eyes and its attention to new interests outside those which more immediately press on its active daily life. Nor, indeed, is it only the child, but (perhaps even more) the adult, whose interest must be stirred and awakened if he or she is to regard the Overseas Empire as a living and inspiring factor in the life of to-day.

After all, when you come to think of it, we are all too prone to go on living a sort of silkworm existence, spinning the threads of self-interest in the cocoons of our own minds. We forget how healthy and exciting it is to break through and take an interest in the world outside. The finest gift which any one person can give to any other person may be summed up in the word " attention." It is when you give your attention to other human beings that you begin to take a real interest in them and perhaps to render them the help which they deserve. Anything else may follow—the service of your brain or your money, your hand, your head, or your heart. All these may follow, and can only follow if your attention is really given. It need not only be to somebody you know and like. I do not suppose the Good Samaritan had ever met before the wounded man who lay on the road before him. If he had not given him his attention in the first instance and then his interest, the loving and loyal services which he did give could never have been vouchsafed.

However, all these are platitudes which are really common property. Suffice it to say then that the work in our Galleries is devoted to capturing the attention and the interest of the children who visit them, and the same with our films and other visual aids. If we can only tell these stories in simple and interesting language, the effect on the child is immediate and lasting. And we feel that even the adults will also understand ! Let me give one or two simple illustrations from the exhibits in our Galleries. By means of story exhibits we describe each of the principal products of the Overseas Empire in our show cases and dioramas. It has got to be a story or the information will not get across. Well, the story of wattle bark begins with a label " South African wattle bark and what it means to the Hiker." Clearly the word hiker means much more to the child than the words wattle bark, and it is in the association of the two that the child's interest is aroused. The story is told by photographs of the plantation, sections of the tree, specimens

of the bark, photographs of the tanning pits and samples of the leather which emerges, and finally of the boots and shoes—and particularly the soles !—which help the hiker on his daily tramp. I could give you lots of other illustrations. In one showcase a rabbit is peeping out of a top hat, with the label " It is quite easy for a conjuror to produce a rabbit out of a hat. But it is not so easy to convert a rabbit into a hat." Then follow New Zealand rabbit skins, the removal of the fur, a picture of the rotating cone which converts the fur into felt—the addition of Indian shellac as a stiffener, and finally the finished grey soft hat or black bowler hat showing how the trick is done. Wool from the Falkland Islands is similarly treated—" How many socks does a sheep wear ? " The answer is that a Falkland Islands' sheep yields approximately 7 lb. weight of wool, which boils and scours down to about 4 lb. weight of yarn, from which one can knit approximately 26 pairs of socks. So the child learns what is a staple industry of the Falkland Islands and how it links up with the daily demands and needs of this country.

Now I turn to the third, and last, section of our Empire Education responsibilities—What is the story which we wish to get across ? I have already told you that we try to stimulate an interest in the Empire by linking up, in the economic aspects of our Gallery exhibits, our films and slides, the Overseas producer with the Home manufacturer and consumer. By means of our dioramas and relief maps we play up to the teacher of Empire geography. By our statuettes of the great Empire-builders and the accounts of their work and achievements, displayed in our Galleries, we assist the teachers of Empire history. And of course our Empire lecturers tell the story of the more human aspects of life in the Empire, from their own personal experiences, in their own experienced and inimitable ways. But I wish this evening to go a little deeper into the background of the Empire story and to give you my own impressions of its value to us—a short Credo of my own personal faith in what the Empire means, or should mean to each one of us Empire-lovers. It is not an easy thing to do in the last ten minutes of my talk, but let me try.

A very brief survey of British history reveals the slow growth of the Empire, in its early stages, quickening in recent days as we pass from the idea of protective rule to that of trusteeship and partnership. To begin with the fifteenth century—that might be described as the Age of Innocence, of voyages, adventures and discoveries, when the New World is found and explored and the stage is set for the greater scientific discoveries to follow. The sixteenth century is the era of buccaneering pure and simple, with Spain and Portugal as our great rivals. During the seventeenth century the interest shifts to overseas trade, with the foundation of the great Trading Companies starting with the East India Company in 1600. Our rivals are now Holland and France, and

the rivalry runs right through the succeeding century, the eighteenth.

At the eighteenth century I should like to pause for a moment and remind you that the struggle for trade supremacy now becomes quite openly and seriously a struggle for sea power, on which successful trading depended. The new conception of the eighteenth century was, that we wished to make the seven seas free, not as an assertion of any monopoly rights of our own, but rather in order to break all foreign monopolies and to ensure that ocean trade and traffic should be equally free and open for all nations of the world. This was the vision of our ancestors and the real beginnings of their greatness. The seas were to be free for all. The benefits were to be universal.

During the nineteenth century this tolerance and vision became more and more evident in the great expansion of our Empire which followed the successful close of the Napoleonic wars. Our campaign against slavery brings us into contact with many countries and into many ports, and particularly into Africa. We carry the flag and open up many scarce-discovered lands, but it is a flag, not of domination, but rather of release and protection—release from fear and protection from raiders and marauders. Many States call us in for their own protection—Indian States, African States, Malayan—Malta, Zanzibar, even distant Tonga and Fiji. In the eighteenth century we became the police of the sea; in the nineteenth century we first checked the excesses of the slave trade and then from our protection of coastlands we passed by natural stages to the protection of hinterlands, pacifying, healing, adjudging, introducing law and order in place of strife.

By the end of the nineteenth century and the beginning of the twentieth, and particularly on the conclusion of the Boer War, the task of expansion is virtually over and the task of consolidation begins. It has been going on ever since. The rise of the great Dominions, from Canada (1867) in the nineteenth century to Australia (1901), New Zealand (1907), South Africa (1910) and Eire (1922) in the twentieth—the Statute of Westminster in 1931—the growth of interest in the Colonial Empire and particularly of the ideas of trusteeship and partnership—the mandates which followed the First World War—right down to the present day.

What is the key-word to explain and confirm these great developments? There is one man who, I think, understands best how these developments came to pass and what they mean to world history. That man is not British; indeed, at one time he was our deadly enemy—he is now our best friend—soldier-statesman-philosopher, who understands and appraises this country with a critical but friendly eye, better than any other foreigner ever did in the past—General Smuts. Listen to what General Smuts said, in introducing in the Union Parliament the bill which conferred on South Africa the privileges and responsibilities inherent in the

Statute of Westminster. He said quite openly that he did not like the word Empire as applied to the British Empire. To him the word Empire always connoted the sense of domination—of a superior race lording it over inferior races—of all that the Roman Empire stood for at its best and worst—even the conception underlying the French Empire, a conception of French citizenship which would spread throughout their Empire, carrying with it the appreciation of French civilisation and culture. It is in many ways a fine conception, said Smuts, but it is not the conception of the British Empire. For, he explained, the British Empire is the first of its kind. It is not an Empire at all, but a Commonwealth—a Commonwealth which has grown and still grows, paradoxically enough, by decentralisation. Its keynote is Service. It exists to strengthen the weak, to educate the ignorant, to protect the oppressed. It rescues all that is best in local laws and customs, social services, administration, arts and crafts and industries. It sustains and develops them. It is not content to give to partner-races the best that science affords ; it also trains them to acquire and apply this knowledge to their own problems in their own interests. It has one single objective, that the country under its protection shall one day stand on its own feet, ruling itself without fear or favour and taking its own unique place in the Councils of World States. We did it in Egypt, we have quite recently done it in Iraq and in Transjordania. We are doing it in India and Burma and Ceylon, in Malaya and Borneo. It is our great contribution to world order, world peace.

Our influence in these countries will go on raising and developing them. It is only by losing ourselves that we find both ourselves and them. Now you see we are coming right to the heart of the mystery—if indeed it is a mystery at all. We believe, and we teach, the supremacy of Law, so that no official is above the law, and even the humblest citizen can and does contribute to the making of the law. Whenever any dispute arises between the individual and the State, that dispute must be referred to an entirely impartial arbiter. In this short statement you will realise at once what importance is attached to the individual. The individual citizen is the unit, not only of the family and of society, but also of the nation, the Commonwealth of Nations, and, indeed, of the world.

That is our path. That is where we differ from the many Empires of the distant past and from the totalitarian States of the recent past, the present and perhaps the future. They believe that the individual citizen is just a cog in a superhuman machine ; that for its strength and survival the State must be united ; and that unity can only come through uniformity. We also believe that the State must attain unity if it is to survive. But we believe also that unity can best be achieved through diversity—not in spite of diversity but through it, by means of it. Every man and woman and every child must have a chance and opportunity to

live his or her life to the fullest, under the protecting care of a State whose strength lies in the very diversity of the characters of its citizens.

And so we come finally to the great freedoms which Churchill and Roosevelt put into words and which represent the finest of our joint traditions and heritage. You know them. Freedom from want—freedom from fear—freedom of speech, of meetings and the Press—freedom of worship. And to these four I should like to add one further freedom, a fifth, freedom from ignorance. Thus we return full cycle to our starting point, the Empire services rendered by the Imperial Institute. We seek to free the child-minds of this country from ignorance about the Empire and particularly from ignorance of the great traditions which we have inherited with it.

Exhibition Galleries.—*Obituaries.—F. W. Rolfe and A. B. Jackson.*—It is with extreme regret that we have to record the death on Friday, June 27, of F. W. Rolfe, Curator of the Exhibition Galleries. Though he became seriously ill in January his death was rather sudden and unexpected.

Rolfe was born at Kew, and, after a normal school career, decided to take up botany. He studied at the Richmond Technical Institute, the Chiswick Polytechnic, and the Royal Botanical Gardens, Kew. In 1907 he was appointed Sub-Assistant in the Herbarium and Library at Kew and during the next four years did a considerable amount of research work in connection with various Kew publications. He assisted Sir George Watt in the production of his valuable textbook, *The Commercial Products of India*, and also helped in the preparation of Elwes' and Henry's *The Trees of Great Britain*.

In 1911 Rolfe joined the staff of the Imperial Institute as Technical Superintendent of the Exhibition Galleries and eventually became Curator in 1943. During the thirty-six years of his service with the Institute he saw the Exhibition Galleries advance to the important position they occupy to-day. Much of the credit for the present lay-out and for the vivid manner in which the Galleries display the products, peoples, and scenery of the British Empire must be given to him.

In the Great War Rolfe saw active service with the Royal Army Medical Corps on the Western Front, and during the more recent hostilities he carried out his full share of Air Raid Precaution and other duties, besides doing everthing possible to carry on the work of Curator and Guide Lecturer in the Galleries.

In 1925 Rolfe was a co-author of *The Romance of the Fungus World*, which still remains a standard work on the subject. His death deprives his many admirers both at the Institute and elsewhere of a sincere and respected friend whose place will be hard to fill.

We also record with regret the death on January 14 last of A. B. Jackson, formerly a member of the Exhibition Galleries Staff. He joined the staff in 1910 and remained with us until 1932, for the greater part of this time being in charge of the section of the Galleries devoted to Australia, New Zealand and the South-Western Pacific. On leaving the Institute he took up part-time duties as a specialist in the Botanical Department of the British Museum (Natural History).

Jackson specialised in the botany of hardy trees and shrubs and in the identification of these plants he became an acknowledged authority. He began work in this connection as an assistant to H. J. Elwes and H. Henry in the preparation of their great work, *The Trees of Great Britain and Ireland*, having previously held for a short time the post of Temporary Technical Assistant in the Herbarium, Royal Botanic Gardens, Kew.

While on the Institute staff he continued with his botanical work and in his spare time found opportunity to catalogue with notes and frequently with illustrations a number of the important arboretums in this country.

With W. Dallimore, of Kew, he collaborated in the production of the *Handbook of Coniferae*, 1923, a standard work of which a third edition was in preparation at the time of his death. His last work to be published was the *Identification of Conifers*, 1946, a handy pocket volume intended chiefly for forestry students in temperate climates. In recognition of his botanical work he was elected an Associate of the Linnean Society in 1917. He was also a member of the Scientific Committee of the Royal Horticultural Society.

General.—The six months under review, January to June 1947, included the period of intense cold which almost paralysed the British Isles in January, February, and March. The fuel crisis, of which this arctic weather was a partial cause and which imposed severe restrictions on the use of electricity, nearly put the Exhibition Galleries out of action and the stillographs and informographs, which use a considerable amount of current, are still not in operation.

The period opened with the Royal Philatelic Society's Exhibition in the Pavilion and a large proportion of the thousands who visited it subsequently made a tour of the Galleries. The Exhibition closed on January 4.

The Galleries were honoured on February 18 by a visit from the First Sea Lord of the Admiralty, Admiral Sir John D. Cunningham, K.C.B., M.V.O., who was accompanied by his Naval Secretary, Captain Sir Charles Madden, Bart., R.N. The visitors spent an hour in the Galleries where the Director, Assistant Curator, and Guide Lecturer explained the general purposes of the Galleries as a visual method of teaching Empire geography. As a result of this much appreciated visit arrangements have been made for

certain Naval Training Classes to include a tour of the Galleries in their instructional courses.

During 1946 a consignment of fifteen cases of the products of the island of Mauritius was received at the Institute. This collection had originally been intended for an exhibition in the Middle East, but this fell through for various reasons and it was hoped at one time to stage a special display and sale in the Exhibition Pavilion of the Institute. This also was found impracticable owing to shortage of staff and to complications regarding both the rationing of food and clothing and the collection and payment of import duties.

It was, however, found possible to use some of the exhibits as a display of Mauritius products at the British Industries Fair at Olympia in May 1947. The display was arranged for the Mauritius Government by the staff of the Exhibition Galleries, two large showcases and one small one being lent by the Galleries to house samples of tea, sugar, Mauritius hemp, tortoiseshell, timbers, and wood-turnery. A large double-sided panel was also used for a small exhibition of paintings by Mauritian artists. Photographs of the island's scenery and industries and a large coloured and illustrated map completed an informative display of the Colony's activities and attractions.

Several showcases and exhibits were also lent to the Trade Commissioner for Burma for use at the British Industries Fair.

In response to numerous requests from schools the time of commencement of the daily cinema display was advanced on March 1 from 3.30 p.m. to 3 p.m. This enables pupils coming from a distance to return to their schools or homes before trains, trams, and buses become congested with homeward-bound crowds. Saturday cinema times remain as before—2.30 and 3.30 p.m.

In April 1947 a number of West African ethnological and other exhibits was lent for use in a Sunday television broadcast in the British Broadcasting Corporation's Children's Hour.

During the same month several examples of Ceylon handicrafts and a selection of photographs were lent to the Empire Tea Bureau to assist in making a window-display devoted to the island at Ceylon House in London.

Attendances.—The bad weather and absence of lighting in the Galleries during the first part of the period under review led to a considerable falling off in attendance figures and to the cancellation of many projected visits by school and other parties. In spite of that, however, the complete period shows a very large increase in attendances as compared with the first half of 1946. The figures for the two periods were as follows:

January to June 1947	63,005	including	381	parties
January to June 1946	29,718	,,	262	,,
Increase	33,287	,,	119	,,

Of the organised parties 353 or 93 per cent. were school classes and parties from Teachers' Training Colleges.

New Publication.—In order to give guidance and advice to teachers bringing parties to the Galleries—or even to individual visitors—a new 10-page pamphlet was issued in May 1947 in which the impossibility of examining more than a very limited portion of the Exhibition Galleries in a 60-minute visit is pointed out. The pamphlet concludes with a list of 13 "Tours," each of which could be concluded in about an hour. Lists are given of ten of the principal products of the territories included in the tour and of any special exhibits relating to the life of the people and the scenery and architecture of their countries. The beginning and end of each of these tours have been marked in the Galleries themselves by notices printed in green.

Teachers wishing to have a copy of this useful publication should either write to the General Secretary or apply personally at the Central Stand in the Galleries, which was re-opened in December 1946.

New Exhibits received.—Her Majesty Queen Mary has again shown her great interest in the Institute by very generously presenting to the Exhibition Galleries a number of examples of West African handicrafts. These consist of a quiver-full of slender wooden arrows with barbed metal heads, eight decorated leather cushion-covers and pouches, a number of small trays made of locally smelted and hand-worked copper, two model copper ingots, three leather and fibre fly-whisks, and a small coloured metal figure of a West African playing a drum. These interesting gifts were received in April 1947.

British Celanese Limited and Courtauld's Limited have co-operated in providing a display of rayon and plastics for the Canadian Court. The exhibit comprises a pyramidal structure at the top of which are shown trees and other sources of the necessary raw materials, while the sides contain "story exhibits" showing various stages in the processes of manufacture. Round the base of the pyramid are groups of finished articles in rayon and plastic.

The South African Railways have presented some excellent photographs which, arranged in sequence, take the visitor for a comprehensive tour of the Union and provide glimpses of several industries and of a number of recreational centres in the four Provinces. Many of the places visited by the Royal Family during their recent tour of the Union are shown and there are splendid photographs of Zulus and other native races. These photographs will be mounted in large swinging frames and opportunity is being taken to include brief notes of historical interest about many of the cities and towns illustrated.

Another extremely generous gift has been made to the Galleries by the Demerara Bauxite Company Limited through the good offices of Aluminium Laboratories Limited of Banbury, Oxfordshire.

This gift, which was specially made for exhibition at the British Industries Fair of 1947, is carried out almost entirely in aluminium; it covers a floor space about 12 ft. by 4 ft. and stands 7 ft. high.

In the centre is an octagonal stand which revolves slowly to show behind each of its eight glass faces an aluminium or bauxite product or some finished article in the manufacture of which aluminium plays an essential part. Surmounting this stand and revolving with it is a 2-ft. high copy of the figure surmounting the Shaftesbury Memorial in Trafalgar Square, better known perhaps as Eros. The original Eros was cast in aluminium.

Resting on a shallow plinth in front of this exhibit is a piece of bauxite as mined weighing about 250 lb. Coloured transparencies on either side of the structure depict the mining, transport, and local treatment of the ore as well as scenes in the vicinity of the mines. A full-sized ingot of aluminium and several finished articles complete a very handsome and informative addition to the British Guiana Court.

Two Nigerian suits of clothes as worn by a small Hausa school boy and girl on the occasion of a Mohammedan festival have been exhibited in the West African Court. These exhibits have been received through the instrumentality of Mr. A. L. B. Hay from the Kano Native Administrations. The boy's dress comprises shirt, trousers, waistcoat, gown, skull-cap, and slippers together with a writing board bearing a chapter of the Koran, a gourd inkpot, and guinea-corn pens. The girl's dress comprises petticoat, short frock, striped cloth worn over the right shoulder, and a silk head-kerchief together with silver bangles, ear-rings, and a necklace of glass beads.

Empire Lantern Slide and Film Strip Library.—During the nine months, October 1946-June 1947, covered by this report, 55,200 lantern slides and 258 film strips have been issued to schools and lecturers in the United Kingdom. The details are as follows:

	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.
Canada	1,740	1,260	480	1,140	900	300	420	780	360
Australia	1,020	840	360	480	240	360	480	480	420
New Zealand	480	900	120	60	180	180	180	600	180
South Africa	180	180	300	480	600	360	180	240	120
India	1,680	2,040	480	1,560	1,260	780	420	660	840
Burma	480	240	240	240	360	420	180	60	120
Colonial Empire	2,820	4,140	2,100	3,420	2,100	2,100	1,020	960	1,620
Products of the Colonial Empire	60	240	240	540	360	180	—	180	120
General Tours	240	360	600	60	120	240	—	180	—
History	480	120	180	60	420	180	—	60	60
	9,180	10,320	5,100	8,040	6,540	5,100	2,880	4,200	3,840

The Canadian Pacific Railway Company has presented a picture talk in duplicate on a journey across Canada by the Canadian

Pacific Railway. Canada is presented as a very large country, the largest in the British Commonwealth, and one in which the railway constitutes an iron back-bone, connecting many far distant places. Travelling over this system we see the modern towns, the Great Lakes, the wheat fields, cattle ranches, apple orchards and the very lovely scenery Canada has to offer. The talk ends with a brief history of the Canadian Pacific Railway, showing the important economic and political contribution it has made to the development of Canada.

Miss D. Hosegood has written a talk about the Kanakas of New Guinea. The natives are described as being in the process of growing up. Some are still Stone Age people, but many now train in Government Schools for useful occupations. The talk illustrates the animals, fishes, and birds of the island and the native crafts of mat-making, weaving and house building.

Mr. Roth, B.A., M.Sc., has supplied the pictures and written a talk on Fiji. He begins with the geographical position of this tropical archipelago showing clearly the importance of its air base as a link between North America, Australia, and New Zealand. Mr. Roth goes on to tell how in 1874 the Fijian representatives voluntarily ceded the government of their country to the British Crown and how under this arrangement they remain in control of practically all their local affairs, settling disputes in their own courts, presided over by Fijian magistrates and holding Annual Councils of their medical practitioners and administrative officers, to discuss organisation of government so far as it concerns Fijians. Here is the famous Central Leper Hospital, which is financed by and serves all the British Island Territories in the Pacific. This is followed by a series of illustrations of the types of houses (corrugated iron and thatch), the agricultural products, sugar, coconuts and pineapples. Finally the various dances and ceremonial occasions, such as the presentations of food and the presentation of a whale's tooth, are used to show the survival of Fijian customs and traditions.

Mr. Cowgill, C.M.G., M.C., lately Resident in Negri Sembilan, has written two picture talks on Malaya. The first is called "The Land and its Peoples" and begins with a journey from London to Malaya thus fixing the position of the country on the map. The introductory pictures show the buildings and streets of Penang, Malacca and Singapore and the description of these towns is accompanied by incidental references to the history of Malaya. We then see the peoples of Malaya in pictures typical of their daily life, leaving for the second talk the main industrial occupations of the Union.

The Malays are represented by a series of illustrations of a Malay village, a fishing boat, an elephant picnic in the jungle and a State procession in Perak. The Chinese are shown as woodcutters, hawkers, letter-writers and by Chinese junks and a funeral procession. Next we see Tamils as gardeners at work and in a

family group and finally the Sakai are shown with blow-pipes and in a Sakai house. The talk ends with scenes in a trade school, an agricultural school, and at Raffles College and with pictures of Boy Scouts and Girl Guides.

In this second talk on "The Principal Industries of Malaya," Mr. Cowgill deals with the ten major products of the country. He makes a more detailed examination of the climatic conditions, and of the position of the ports and railways, and of the reason which led the rulers of Malaya to invite British protection. After commenting on the phenomenal increase in production, prosperity and well-being of the people which followed the establishment of law and order, Mr. Cowgill discusses various methods of tin-mining according to the form in which it occurs, the planting of rubber, collection of latex and the manufacture of smoked sheet. After these two main industries he explains the importance of rice in the Malayan economy and then deals with fishing, coconuts, oil palm, pineapples, tea, tapioca and forest products.

Central Film Library.—The slight falling off in the demand for films during the months immediately following the war was continued through most of 1946, but the trend seems now to be definitely reversing itself. Despite cancellations due to the restriction on fuel and power, the first six months of this year have shown a return to the upward trend with an 8·7 per cent. increase over the corresponding period for last year. Heavy advance bookings indicate that this improvement is likely to be maintained throughout 1947.

Figures of films circulated by the Library for the eight months ended June 1947, compared with those for the previous year, are given in the following table:

	Empire.		G.P.O.		C.O.I.		Total.	
	1946-47.	1945-46.	1946-47.	1945-46.	1946-47.	1945-46.	1946-47.	1945-46.
November	2,762	3,230	506	561	6,204	5,761	9,472	9,552
December	1,961	2,308	396	419	4,896	4,820	7,253	7,547
January	2,933	2,865	545	495	5,566	4,746	9.044	8,106
February	3,101	3,336	557	569	6,365	5,299	10,023	9,204
March	2,839	3,298	538	585	6,726	5,745	10,103	9,630
April	1,725	1,610	344	325	3,825	3,890	5,894	5,825
May	2,326	2,453	461	447	4,221	3,785	7,008	6,685
June	2,373	1,883	497	376	3,776	3,095	6,646	5,354

A recent review of the various borrowers who have made use of the Library during the last eighteen months shows that out of a total of 5,216, no fewer than 1,692, or 32·4 per cent., have been from primary and secondary schools. The full analysis of organisations receiving films during this period is shown under the group headings listed as follows:

	No.	*Per cent.*
Secondary Schools	871	16·7
Primary Schools	821	15·7
Churches and Missions	502	9·6
Clubs (social, political, etc.)	501	9·6
Commercial Firms	391	7·5
Army, Navy and R.A.F.	372	7·1
Colleges and Universities	264	5·1
Local Authorities	204	3·9
Hospitals and Sanatoria	181	3·5
Institutes and Associations	168	3·2
Government Departments (and branches)	115	2·2
Agricultural Bodies	92	1·8
Scouts and Guides	88	1·7
Film Societies	87	1·7
Prisons and Approved Schools	52	1·0
Miscellaneous	507	9·7

New Films.—A large number of new films have been added to the Library by the Central Office of Information. Principally, but not entirely, films of the United Kingdom, they include such titles as "The Beginning of History," "Instruments of the Orchestra," "Approach to Science," "Triumph Over Deafness" and further additions to the series of single-reel magazines, "Britain Can Make It."

New films of the Overseas Empire now in general circulation include:

CANADA.

Trees that Reach the Sky	The use of Sitka spruce in the construction of aeroplanes.
Canadian Wheat Story	The harvesting and milling of Canadian wheat.
Cattle Country	The care and raising of cattle in the Canadian West.
Chants Populaires (Selection A)	Two popular French-Canadian songs illustrated by animated drawings.
Chants Populaires (Selection B)	As above.

SOUTH AFRICA.

Africa No. 3	A cine-magazine— (1) Buildings in Cape Town. (2) Sisal production.

INDIA AND PAKISTAN.

Bassein Village	Life in an Indian fishing village.
India Down South (Silent)	The Todas in the Nilgiri Hills; occupations in the backwaters and countryside of Cochin.
Across North India (Silent)	Pilgrims at Benares; Akbar's deserted city of Fatehpur Sikri.
Indian Background	The contrast of primitive and modern in present-day India.

Empire Lectures to Schools.—In recent notices under this heading reference has been made to the continuing growth of the Scheme. In the autumn term 1946 (mid-September to mid-December) 2,000 lectures were given to schools in all parts of England and in Southern Scotland, bringing the total for the calendar year to 4,044. The

financing of the Scheme had given rise to anxiety for some time as the Institute was aware that grants from trust funds on which the Scheme had largely depended would cease when the Trusts concerned (Leverhulme, Rhodes and Imperial Relations Trusts) resumed their normal peace-time activities. In the circumstances, after consultation with the Ministry of Education and the Colonial Office, it was decided to ask local Education Authorities to contribute to the fees and expenses incurred at the rate of 35*s.* for each lecture. It was realised from the first that this proposal might mean that some of the Authorities, despite the enthusiasm of their schools, might be unable to participate. Nevertheless, it was hoped that the success achieved during the past six years would encourage a sufficient number of the Education Authorities to accept the new terms to ensure the continuance of the Scheme. This hope has been fully justified, and, although the number of lectures given in the first two terms of 1947 was only just over one-half the figure for the corresponding period of 1946, the decrease might well have been even more substantial. The Education Committees necessarily require some considerable time to arrive at a decision, and until that decision is forthcoming, no arrangements, which are normally made some time in advance, can be undertaken. The difficulties encountered during this transitional period have now been largely overcome and engagements entered into for the autumn term exceed two-thirds of the number dealt with during the autumn term of last year. In addition, contacts with Education Authorities are continually being extended. There is indeed a reasonable prospect that the Scheme will, in due course, regain and possibly improve upon the position which it had gained in 1946.

Throughout the period under review, close contact has been maintained with the Empire Panel of Inspectors of the Ministry of Education. Representatives of the Panel have taken an important part in recent Lecturers' Conferences and arrangements have been made with the Ministry for the local Inspectors to be advised of lectures given under the Scheme, so that they may have an opportunity to attend should they so desire.

Although there has been the usual loss of lecturers, these vacancies have been more than made good, and the following have joined the Scheme since the last note was published: Mr. H. L. Debi (Trinidad), Mr. R. N. Murray (Jamaica), Mr. Francis Bowen (Jamaica), Mr. P. J. Hackforth (Australia), Miss M. A. B. Attlee (South Africa), Mr. J. F. S. Salgado (Ceylon), Mr. J. O'Donovan (Seychelles and East Africa), Miss B. McKechnie (General Empire), Brigadier Stokes-Roberts (West Indies), Mrs. D. Murphy (Canada) and Lieut.-Colonel Crocker (General Empire).

In addition, it is hoped to have the assistance of a number of Colonial Officers and overseas visitors on long leave in the United Kingdom.

Colonial Visitors.—The following is a list of officers on leave from the Colonial Empire who have visited the Institute during the seven months ending June 1947:

DECEMBER 1946

P. A. ALLISON, Assistant Conservator of Forests, Nigeria.
Dr. N. G. BAPTIST, Chemist, Salt Department, Ceylon.
H. A. M. BECKLES, Master, Queen's College, British Guiana.
W. E. CALTON, Government Chemist, Zanzibar.
Dr. J. G. GIBBS, Director of Agriculture, Falkland Islands.
F. R. JOHNSON, M.B.E., Director, Fisheries Research, Gold Coast.
Miss G. PLUMMER, Deputy Director of Education, Nigeria.
J. D. POLLETT, Acting Director, Geological Survey, Sierra Leone.
V. B. V. POWELL, Principal, Education Department, Nigeria.
A. WEERASINGHE, Commissioner, Agricultural Corps, Ceylon.

JANUARY 1947

T. F. BETTS, Assistant Conservator of Forests, Nigeria.
R. R. CAMPBELL, Master, Royal College, Mauritius.
Dr. W. J. EGGELING, Conservator of Forests, Uganda.
F. LEACH, Secretary, Commerce and Industry, Gold Coast.
W. E. M. LOGAN, Assistant Conservator of Forests, Gold Coast.
P. L. MELLIAR-SMITH, Inspector of Mines, Malaya.
SIR CHARLES WOOLLEY, K.C.M.G., O.B.E., M.C., Governor and Commander-in-Chief, Cyprus, and Governor-Designate, British Guiana.

FEBRUARY

P. ADAMES, Agricultural Officer, Sierra Leone.
G. S. CANSDALE, Assistant Conservator of Forests, Gold Coast.
Dr. W. PULFREY, Senior Geologist, Mining and Geological Department, Kenya.
D. M. SMALLEY, Senior Agricultural Officer, Nyasaland.
A. W. THOMPSON, Senior Assistant Agricultural Officer, Kenya.
W. A. TOOKE, Chemist, Geological Survey Department, Malaya.

MARCH

N. M. Assheton, Administrative Officer, Gold Coast.
C. BELL, Education Officer, Nigeria.
N. R. FUGGLES-COUCHMAN, Agricultural Officer, Tanganyika Territory.
O. D. WRIGHT, Headmaster, Northern Rhodesia.

APRIL

D. C. EDWARDS, Senior Agricultural Officer, Kenya.
H. C. KING, Conservator of Forests, Mauritius.
L. E. PITOT, O.B.E., Public Works Department, Mauritius.
A. L. POTTER, Master, Educational Department, Hong Kong.
R. TURNER, Agricultural Officer, Nigeria.

MAY

M. AKENHEAD, Agricultural Officer, Gold Coast.
Mrs. D. M. D'ALTON, Senior Assistant Mistress, Education Department, Uganda.
Miss E. M. BALDRY, Education Officer, Mauritius.
J. S. CONGREVE-SCOTT, Manager, Tanganyika Fibre Board Factory.
P. S. DEMPSEY, European Master, Education Service, Malaya.
R. J. DEWAR, Assistant Conservator of Forests, Nigeria.
W. D. HAVERSON, Assistant Commissioner of Mines, Kenya.
T. W. HUSSEY, Assistant Conservator of Forests, Nigeria.
C. J. MILLAR, Assistant Conservator of Forests, Trinidad.
T. I. REES, Assistant Conservator of Forests, Nigeria.
N. R. REID, O.B.E., Senior Veterinary Officer, Tanganyika Territory.
J. B. SMART, Assistant Conservator of Forests, Kenya.
C. SWABEY, Conservator of Forests, British Guiana.
G. WATKINS, Assistant Conservator of Forests, Tanganyika Territory.
J. D. YELF, Agricultural Officer, Northern Rhodesia.

JUNE

F. W. ASTON, Senior Veterinary Officer, Kenya.
Miss G. E. ATHERTON, Headmistress, Fiji.
F. M. COSTER, Engineer Geologist, P.W.D., Tanganyika Territory.
T. G. HARVEY, Schoolmaster, Northern Rhodesia.
G. E. M. LATIMER, Veterinary Officer, Nigeria.
R. J. SIMMONS, Director of Veterinary Service, Nigeria.
W. A. TOOKE, Chemist, Geological Survey Department, Malaya.

All Dominion and Colonial Officers, as well as private residents from the Overseas Empire, who may be visiting London, are cordially invited to come to the Institute to see the Exhibition Galleries and to discuss with the Director and his staff, scientific and technical problems in which they may be interested.

BULLETIN
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PLANT AND ANIMAL PRODUCTS

ARTICLE

THE COCOA-PROCESSING INDUSTRIES[1]

By CHARLOTTE LEUBUSCHER, Dr.Phil.

I. COUNTRIES GROWING COCOA AND COUNTRIES MANUFACTURING COCOA GOODS

THE outstanding fact concerning the processing of cocoa is that—with few and, so far, not very important exceptions—in all the cocoa-growing countries processing is carried no further than the fermenting and drying of the cocoa beans after they have been removed from the pods. In other words, only those manipulations are applied in the producing countries which are indispensable for the preservation of the produce and its transport overseas. Another important fact is that by far the greater part of raw cocoa is exported, that is to say, enters world trade. Only a small proportion of the cocoa crop is used in the producing countries in South America while in the West African cocoa-growing territories, which are responsible for approximately 66 per cent. of the world's cocoa exports,[2] virtually the whole of the cocoa crop is exported. Even in Brazil, the second largest producer of cocoa after the Gold Coast, about 96 per cent. of the crop was exported before the war and only in recent years has a higher percentage been retained for further processing in the country.[3]

[1] This is the first of a series of studies dealing with the processing of certain raw materials from tropical areas in the production of which British Colonies have an important share. The object of the studies is to show what factors are responsible for the present organisation of the industries processing these raw materials and what prospects there are for changes in the location of these industries. The research work of which the studies are the result has been made possible by a grant under the Colonial Development and Welfare Act and has been sponsored by the Colonial Economic Research Committee.

[2] See Table I.

[3] According to Reports by the Bahia Cocoa Institute, as much as a fifth to a quarter of the whole crop is now retained in Brazil for further processing. See also p. 239.

This large proportion of the cocoa crop which is normally exported from all the producing areas allows the published figures of world exports to be taken with a fair amount of certainty as representing world production of raw cocoa.

From the point of view of the present study the large share of the raw material which originates in colonial territories is of particular interest. Colonies—British and others—were responsible for over 70 per cent. of the total cocoa exports in both 1928 and 1938, their share having steadily risen since the end of last century when it amounted only to somewhat over two-fifths of world exports.[1]

This change coincided with the increasing supersession of "fine" cocoa (Criollo) grown mainly in South America by "ordinary" cocoa (Forastero) grown largely in Africa, and more recently also in Brazil. British Colonies were to a large degree responsible for the large increase of colonial production of cocoa, accounting in 1898 for between one-fifth and one-fourth of world production, but for over three-fifths in 1928. The decrease to about one-half of world production in 1938, in spite of further increases in output in both Nigeria and the Gold Coast, was mainly due to larger contributions of non-British producers—i.e. Brazil, the Dominican Republic, and the French West African cocoa-growing dependencies—the Ivory Coast and the French Cameroons—and to a lesser extent to a drop in the cocoa crop of Trinidad.

Commercial conditions at the other end are in some respects almost the reverse of those governing the marketing of the raw material. Although it would be misleading to say that manufactured cocoa products are not traded internationally, it is nevertheless a fact that—with one important exception—the bulk of the principal commodities derived from the cocoa bean, namely chocolate in various forms and cocoa powder, is sold in the domestic markets of the different manufacturing countries. Thus of the "Cocoa Preparations" produced in the United Kingdom in 1935 only 8 per cent. was exported, mostly to the Dominions.[2] In the same year no less than 99·2 per cent. of the home market in cocoa preparations was held by British goods.

Another remarkable feature is the small number of countries where cocoa is processed on a large scale. Although in the inter-war period a great number of countries have taken up the manufacture of chocolate, usually under the shelter of high import duties, there were in 1939 only five countries, viz., the United Kingdom, Germany, the Netherlands, France, and the United States, that could be deemed large manufacturers and consumers of cocoa products. Even more surprising is the fact that the combined share of these five countries of world imports of cocoa beans had changed very little over the last 40 or 50 years, amounting to 82

[1] See Table II.

[2] *United Kingdom. Fifth Census of Production. Final Report.* Part III, 1940, p. 72.

per cent. in 1898, to 81 per cent. in 1908, and to 78 per cent. in both 1928 and 1938.[1]

The very considerable increase in world exports of cocoa beans from 86,800 tons in 1898 to 706,896 tons in 1938 has therefore been absorbed in the main by those countries that were the principal importers even before the last war.[2] There have been, however, important modifications in the share taken by each of these countries.

Another striking fact is the preponderance of Europe in both the processing of cocoa beans and the consumption of cocoa products[3] —a preponderance which was still considerable in 1938, though it had been reduced in comparison with earlier years by the rapid increase in cocoa imports into the United States after the first world war. This is clearly shown by the following figures of the distribution of cocoa imports between the continents in 1898 and 1938 respectively :

Continent	*Percentages of World Imports of Cocoa Beans*	
	1898	*1938*
Europe	85·3	62·4
America	13·8	35·0
Australia	0·5	1·7
Asia	0·4	0·5
Africa	—	0·4

II. THE ORGANISATION OF THE INDUSTRIES PROCESSING COCOA

From an economic point of view, the organisation of the industries using cocoa as sole or principal raw material is simple in so far as there exists no material which is competitive with, or a substitute for, cocoa in its main industrial uses ; a complicating factor which is of considerable influence on prices and on the whole industrial structure in the case of many other raw materials is thus absent. Only in a wider sense can it be said that cocoa and chocolate have to compete in the market of consumers' goods with other foodstuffs or drinks—sugar confectionery, ice creams, or fruit juices, for instance.[4] Furthermore, the industrial uses to which cocoa or its constituent parts can be put are relatively few. As will be shown later, the principal complication in the organisation of the industries processing cocoa springs from the fact that the by-products resulting from the main lines of manufacture, particularly cocoa cake, may be diverted to various uses, and that the choice between these different uses is apt to be influenced by fiscal measures.

The manufacture of chocolate and goods containing chocolate

[1] See Table III.

[2] A sixth country, Switzerland, that was an important exporter of chocolate goods until the nineteen hundred and twenties, was never one of the major importers of cocoa beans, since it produced mainly milk chocolate which has a relatively small cocoa content. It may be also that the Swiss industry bought part of its cocoa beans *via* another importing country, i.e. Germany, Holland or France.

[3] See figures of consumption on p. 234.

[4] Cocoa as a beverage can hardly be said to be competitive with either tea or coffee.

is by far the most important line of production in which cocoa is used as raw material. In the chief manufacturing countries, production is carried on by a number of great concerns of world-wide reputation and, in addition, by numerous less known smaller firms. In the United Kingdom, for instance, according to the last Census of Production (1935), there were 91 cocoa- and chocolate-manufacturing establishments employing 39,308 persons, although only eight or nine firms are more generally known. Many of the smaller establishments are not direct buyers of cocoa beans, but make chocolate from a semi-finished product, cocoa mass, which they buy from the large manufacturers.

In the manufacture of chocolate, not only is the whole content of the cocoa bean, apart from the shells and moisture, absorbed in the process, but additional cocoa butter—the oil contained in the bean—is added to a varying degree. The largest amount of butter is required in the manufacture of milk chocolate, and the growing popularity of this kind of chocolate from the beginning of this century has therefore resulted in a considerably increased demand for cocoa butter. The production of cocoa butter occupies thus a vital position in the organisation of the industries processing cocoa, and the butter is by far the most valuable constituent part of the bean.

Before the war, in the principal chocolate-manufacturing countries, the larger firms used to obtain part of their requirements of cocoa butter within their own establishments; some of them, especially in Germany and the United States and to a lesser degree also in Great Britain, were even exporters of cocoa butter. In addition, in all the large chocolate-manufacturing countries a separate industry had been developed which made the extraction of cocoa butter its main object and sold its product to the chocolate industry.[1] In this country, the cocoa butter industry is rather young, the first works, the British Cocoa Mills in Hull, having been set up only in 1935; during the war a further plant was established under the same management near Reading,[2] and the output substantially increased.

A unique position in the production and export of cocoa butter has been held for many years by Holland where before 1939 no less than 90 per cent. of world exports of cocoa butter originated. Many Dutch establishments combined the manufacture of chocolate and of cocoa powder with that of cocoa butter, but a number of important factories concentrated on the production of cocoa butter as their main or sole object.[3] Although cocoa butter manufactured in Holland went to a great many countries—the Dutch statistics

[1] A small proportion of the output goes to the pharmaceutical and the cosmetics industries.

[2] It was not possible to get any information on a third cocoa mill said to be operating in this country.

[3] See *Les Industries des Pays-Bas, leur Localisation géographique et leur Evolution*, by Fred Cornelissen. Paris, 1932, pp. 92-93.

for 1938 enumerate 25 countries to which cocoa butter was exported —the bulk of cocoa butter exports from Holland were taken by Great Britain, Belgium, France and Switzerland—all countries with important and high-grade chocolate industries. The United Kingdom was before the war by far the largest buyer of Dutch cocoa butter, taking in 1938 about 38 per cent. (over 9,000 tons of a total of 24,000 tons) of all Dutch cocoa butter exports.[1] The Netherlands were the principal external source of cocoa butter for the British chocolate industry supplying in 1938 about 98 per cent. of all imports.

On their part, the Dutch manufacturers of cocoa butter used to buy considerable quantities of cocoa cake (the residue of the cocoa nib after extraction of the greater part of the fat) from abroad, Great Britain being the main supplier. By chemical process they obtained from this cake the remaining oil (sometimes called "cocoa meal butter" in distinction to the higher valued "cocoa butter" extracted from the nib) and exported it. On balance, however, Holland is, or rather was, an exporter of cocoa cake, the main buyer being the United States where the cake is used by the industry manufacturing theobromine for coco-cola and similar drinks.

During the war the situation has been considerably changed, whether permanently or only temporarily is not yet clear. Several countries which had an industry extracting cocoa butter before the war have developed that industry in order to replace supplies obtained hitherto from Holland. Furthermore, a modern plant for the extraction of cocoa butter has been set up in Brazil—a development about which more will be said later.

The extraction or other removal of cocoa butter from the nib (i.e. the shelled and broken-up bean) leaves as residue a considerable amount of cocoa cake with a fat content varying according to the methods used in obtaining the butter.[2] This cake may be utilised in a number of ways. One method is the conversion of the cake into cocoa powder which is thus a complementary product to cocoa butter. Holland in particular has developed, concomitantly with the production of cocoa butter, a large export trade in cocoa and chocolate powder, while the other chocolate-manufacturing countries sell cocoa powder in the domestic market. Good cocoa powder requires, however, a fat content of at least 20 per cent.[3] The use of the cake for that purpose does not therefore allow the extraction of cocoa butter down to a low percentage. Moreover, since the demand for chocolate, and particularly for milk chocolate, considerably outran, in the inter-war period, the demand for cocoa powder,

[1] *Gordian*, January 2, 1939, p. 141.

[2] The fat content of the cocoa bean is on the average 45 per cent. Where, as before the war in Holland and at present in this country, nearly the full fat content is extracted, 100 tons of raw cocoa yield approximately 44 tons of cocoa butter, 38 tons of cocoa cake and 18 tons of waste. *Imperial Economic Committee. Plantation Crops*, 1937, p. 65.

[3] This, at least, is the view held in this country; Dutch cocoa powder has in general a lower fat content.

not all cocoa cake left after the extraction of the butter can be used profitably in that way.[1]

Another process which is often linked to the production of cocoa butter, either in the same undertaking or in separate factories, is the extraction of theobromine from the cake after almost all the fat (with modern methods down to 1 per cent.) has been taken out. The manufacture of theobromine, which is used for medicinal purposes and as a stimulant, was developed before the war mainly in Holland, Germany, Switzerland and the United States.[2] This country imported most of its theobromine from Holland, but with the increased wartime demand for theobromine, domestic production appears to have been developed on a fairly large scale by both the larger chocolate firms[3] and the two cocoa mills at Hull and Reading.

Theobromine is also contained in the cocoa shell, but only in such small quantities (1 to 1·5 per cent.) as to make its extraction commercially unprofitable. The shells are sold by the manufacturers either as cattle food or as fertiliser; because of its theobromine content which has, above a certain point, a toxic effect on the animals, cocoa cake is by the law of this country forbidden to be used for feeding purposes otherwise than in a mixture with other feeding stuffs.

The de-theobrominised cake, which undergoes important chemical changes during the process, is sold as a fertiliser, but is commercially of little importance. Where theobromine is manufactured by the chemical industry, as, for instance, in the United States, the raw material, that is to say cocoa cake, is either purchased from the domestic chocolate industry or imported—in pre-war years mainly from Holland. Nowhere, as far as could be ascertained, are cocoa beans imported with the primary object of manufacturing theobromine.

Although under the present organisation, as the result of scientific research,[4] a number of industrial processes are based on cocoa as

[1] Before the large increase in the consumption of eating chocolate and the resulting increased demand for cocoa butter, cocoa powder was the main product and cocoa butter the by-product. In Holland, the greatest exporter of cocoa powder, the production of that commodity was in 1935 less by 45 per cent. than it had been ten years earlier, while the production of cocoa butter was higher by 30 per cent. and the production of cocoa cake had doubled. *Gordian*, September 25, 1937, pp. 16-17.

[2] According to an American source, the production of theobromine in Europe was roughly divided between the different countries as follows: Netherlands 45 per cent., Germany 20 per cent., Switzerland 15 per cent., France 10 per cent., other countries 10 per cent. *United States Department of Commerce, World Trade Notes on Chemical and Allied Products*, October 30, 1937.

[3] i.e. Cadbury, Rowntree and Nestlé, according to information from the industry.

[4] See, for instance, "A Note on Cocoa By-Products," by S. Bartlett, *National Institute for Research in Dairying*, April 1945; "Chocolate and Cocoa Products. Their Relation to Pharmacy," by A. Churchman, *Pharmaceutical Journal*, August 3, 1935, p. 134; "Cocoa Shells. A Review of its Uses," by A. W. Knapp, *Food Manufacture*, November 1930, p. 319; *Report and Proceedings of the Cocoa Research Conference*, May-June 1945, *Col. No.* 192, 1945, especially pp. 59 *et seq.* and pp. 158 *et seq.*

principal raw material and virtually every particle of the cocoa bean, apart from moisture and unavoidable waste, is put to some economic use, the manufacturers of chocolate and of cocoa butter alone are responsible for the import of cocoa beans from the producing countries, while the other industries are using by-products of these two industries.

III. Factors responsible for the present Location of the Industries processing Cocoa

What factors are primarily responsible for the present location of the cocoa-processing industries? Two questions require examining in this respect. First: Why is practically no processing located in the cocoa-growing countries? And second: What factors account for the present distribution of the industries between countries of the temperate zone?

(1) Taking a historical starting point, it is worth noting that the earliest use of cocoa as a foodstuff was not made in the countries where chocolate industries have been developed later, but in the producing countries of South and Central America, where the Spaniards found cocoa preparations in use in the early sixteenth century. From time immemorial the natives of these countries used to roast the beans and to grind them into a powdery mass which by some simple processes was then formed or rolled into an eatable cake without the addition of sugar.[1] It was in this form that cocoa was introduced to Europe and sold to other countries by the Spaniards. Even now cocoa is prepared in that way in South and Central America as a domestic food. In Europe, however, as soon as the trade monopoly in cocoa which the Spaniards tried to maintain had been broken, efforts were made to produce a refined and more digestible product, and from the eighteenth century onwards inventions designed to improve the methods of preparing and utilising cocoa beans were made successively in various countries —in France, England, Germany, Switzerland, and Holland in particular. At the same time, the manufacture of cocoa or chocolate powder and, during the nineteenth century, of eating chocolate also has been progressively developed in the industrially leading European countries. To these the United States has been added as a major manufacturer of cocoa goods since the beginning of the present century.

There are a number of factors which may be named as accounting for the absence of manufacturing industries in the tropics in general—lack of machinery and of skilled labour, the difficulty and higher cost of enlisting the services of engineers and other specialists, the lack of power and in many cases of additional ingredients required by particular industries, the absence of other industries with which

[1] See Historicus (Richard Cadbury), *Cocoa: All about it*, 1896.

a linkage would be rational, etc. Moreover, the economic doctrine which was dominant at the time when many colonial raw materials came into more general use in Europe, viz., that no manufacturing industries should be developed in the colonies, has undoubtedly continued to influence the division of labour between colonies (including former colonial territories which had meanwhile attained independence) and the various mother countries.

All these factors have some relevance to cocoa, but they are not the decisive factors in its case. Climatic conditions combined with consumers' demand suggest themselves as the basic factors to which the location of the cocoa-processing industries must be ascribed. In no tropical country has the storage of raw cocoa so far been found practicable for any length of time, and as regards the manufacture of chocolate, storage of the finished product under tropical conditions presents even greater difficulties. To this has to be added the fact that, in West Africa at least, no sugar is available locally.

That the chocolate industry avoids areas of high external temperature is borne out by the sites chosen for cocoa and chocolate-manufacturing plants in countries extending over several latitudes, such as the United States, Brazil and Australia.[1] In these countries such plants have been set up not in the areas producing the raw material, but in parts of the country where the climate is more temperate, usually near the seaboard.

On the consumers' side the climatic factor supplies likewise part of the explanation for the location of the industries—eating chocolate and especially cocoa as a beverage are generally more appreciated in cooler latitudes than in areas of high temperatures.

There is no internal demand for cocoa products in the chief producing areas, at least in West Africa. The situation is somewhat different in the American cocoa-growing countries, but it is a significant fact that there too, in spite of the centuries-old acquaintance with cocoa and the more advanced economic stage of these countries, no modern industries manufacturing chocolate or cocoa powder have been developed, apart from a relatively insignificant industry in Brazil.[2]

Taking these various factors together, it is hardly a matter for surprise to find the manufacture of cocoa powder and chocolate developed most highly in the industrially advanced countries of

[1] In Australia, for instance, the Cadbury-Fry-Pascal concern chose in 1921 for its factory a site in Hobart because of the cooler climate of Tasmania compared with the Australian mainland, although this situation had disadvantages from an economic point of view. See Jolo A. Williams, *The Firm of Cadbury, 1831 to 1931*, 1931, p. 141.

[2] It is not without interest that the Brazilian chocolate industry imports about 50 per cent. of its raw material from Venezuela, because the taste of Brazilian consumers demands a blending of the "ordinary" Bahia product with "fine" cocoa. "Cocoa. World Production and Trade," *Empire Marketing Board*, 1930, p. 31.

the temperate zone where the factory equipment is produced and the market for the manufactured goods close at hand. The weight of the latter factor is increased by the fact that up to a certain point national food habits and preferences play a part in determining what kind of cocoa product is mainly in demand in each country.

(2) Turning now to the factors which have influenced the distribution of the cocoa-processing industries among countries of the temperate zone, it seems clear that the original location of these industries cannot be ascribed to any single factor. It is easier to trace changes in more recent years to particular measures of economic policy.

In the earlier centuries, easy commercial access to the raw material through the possession of cocoa-growing colonies no doubt favoured the manufacture of cocoa preparations—first in Spain, and later in France, England and Holland, but inventions in the technique of processing have also played their part. Thus the leading position of the French chocolate industry in the eighteenth century was largely due to the fact that the first machinery which made it possible to turn out a more refined product than was obtained by the crude methods brought by the Spaniards from America, was invented and built in France. Van Houten's invention, in 1828, of extracting the oil from the cocoa bean has undoubtedly helped in making Holland the foremost producer of cocoa powder and cocoa butter. Again, the invention of milk chocolate by Daniel Peter in Vevey in 1862 became, together with the availability of plenty of good milk, the foundation of the Swiss industry's international reputation and prosperity.

In other countries the development of chocolate-manufacture has been furthered by the availability of sugar at a low price. Thus the growth of chocolate industries in Germany and Belgium was greatly stimulated by the establishment of beet sugar industries in these countries during the nineteenth century, while in the United Kingdom the chocolate industry profited from various reductions of the sugar duties.

Since the cocoa and chocolate industries produce largely for the domestic market, the standard of living in the manufacturing country is no doubt a factor of considerable importance for the development of these industries. Even in the most advanced countries chocolate and cocoa have become foodstuffs for the broad masses only in the inter-war period, and in many countries where climatic conditions are not unfavourable, consumption of cocoa products is still very low or even non-existent—in Russia and over the whole of Asia in particular. This shows that cocoa and chocolate are still luxury foods for peoples whose standard of living is low compared with that of the countries of Western civilisation. In Russia the absence of cocoa products from the people's

diet is due to the exclusion, or restriction, of raw cocoa from state-controlled imports.[1]

It is impossible to give accurate per-head figures of the consumption of cocoa in various countries, because the cocoa content of imported or exported manufactured goods is not known. The figures usually given are based on the net import of cocoa beans. That this method may produce rather misleading results, has been shown in the periodical *Gordian*,[2] where an attempt was made, for the years 1925 to 1932, to present rectified per-head figures by taking estimates of imported and exported chocolate goods into account. The results, although referring sixteen and more years back, are still interesting, firstly, because they show that there is a considerable divergence between the crude and the rectified figures, and, secondly, because the relative position of the different countries was presumably in 1939 still more or less what it had been in 1932. In the following Table, in which the results for the first and the last year of the enquiry are reproduced, " K " stands for the crude, and " KE " for the rectified figures.

CONSUMPTION OF COCOA BEANS PER HEAD OF THE POPULATION IN CERTAIN COUNTRIES

(*Kg.*)

Country.	*1925.*		*1932.*	
	K	KE	K	KE
United States	1·42	1·40	1·71	1·52
Netherlands	6·42	1·60	4·98	1·47
Belgium	0·90	1·28	1·11	1·47
Switzerland	1·75	0·89	1·32	1·43
Great Britain	1·27	1·25	1·47	1·36
Denmark	0·61	1·01	1·01	1·36
Germany	1·26	1·23	1·24	1·22
France	1·09	1·17	1·08	1·04
Canada	0·77	1·14	0·77	1·10
Austria	0·72	0·80	1·00	0·99
Czechoslovakia	0·54	0·59	0·70	0·80
Sweden	0·61	0·68	0·71	0·78
Norway	0·76	0·71	0·70	0·70
Spain	0·44	0·44	0·41	0·43
Argentine	0·12	—	0·37	—
Hungary	Not available		0·27	0·30
Italy	0·20	0·22	0·16	0·18
Poland	0·04	—	0·17	—

The two sets of figures bring out clearly the influence which

[1] According to the Russian author of a book on " Cocoa," W. P. Malejew (reviewed in *Gordian*, October 10, 1934, pp. 17 *et seq.*), serious attempts were made in Russia before the recent war not only to produce certain cocoa products, especially cocoa butter and theobromine, synthetically, but also to grow cocoa plants in hot-beds, with a view to transplanting them later to the milder climate round Batum, " where, however, the plantations will have to be roof-covered in winter."

In Germany, under the " guns before butter " policy of the thirties, the import of cocoa beans was restricted to 70,000 tons per annum. That this restriction was much to the discomfiture of the German chocolate industry is amply evident from *Gordian*, the leading periodical for all industries interested in cocoa, which used to be published (in German and English) in Hamburg.

[2] *Gordian*, February 25, 1933, p. 19.

the export of manufactured cocoa goods had on the per-head figure of "consumption" in the case of Holland and, in 1925, also of Switzerland, the only two countries where the industries had been primarily developed with an eye to export, and show further the decline of the export trade in both countries. In the case of Switzerland this decline went so far as to turn a once strongly active balance of trade in chocolate goods into a slightly passive one in the later year. The figures for Canada reflect the fact that that country is, or was in 1932, still to a fairly large extent a net importer of cocoa preparations. Finally, although they should be accepted with some discretion, the figures make evident that, even in many European countries, the consumption of cocoa and chocolate was still very low between the wars.[1]

Although in 1938 five countries still accounted for almost four-fifths of all imports of cocoa beans, a certain dispersal of processing took place from the beginning of the century, a development which was hastened by various measures of economic policy during and since the first world war. Chocolate industries were established and fostered by import duties, and sometimes by more direct fiscal measures, in several overseas countries, in particular in the British Dominions and some South American countries. The high import duties in these countries induced European manufacturers to set up manufacturing plants there. Thus the big British chocolate firms built factories in Australia, New Zealand and Canada where formerly they had had trading agencies, while the Nestlé concern has set up plants for manufacturing its various products in South Africa, in the Argentine and several other countries.

Import duties and other discriminatory measures have, however, induced transfer of manufacture not only to overseas countries with young domestic industries, but the same factor has been instrumental in bringing about changes in the location of the cocoa and chocolate industries in Europe.

The Swiss industry, which was largely organised for export, appeared to have no difficulty in recovering its foreign markets after the first world war, but soon its exports encountered obstacles owing to the protectionist measures applied by nearly all its foreign customers. The position worsened considerably during the economic depression of 1929 to 1933, the adoption of protection by Great Britain being a particularly heavy blow for the Swiss export trade in chocolate goods.[2] The Swiss industry was therefore compelled to transfer production to inside the customs barriers of its former markets and to adapt its production in Switzerland to the requirements of the home market.

[1] Since 1932 was the trough of the depression, it may be assumed that figures were particularly low in that year and that in the following years the picture would have been somewhat more favourable.

[2] Swiss exports in cocoa powder, chocolate dough and chocolate show the following remarkable development: (*continued at foot of next page*).

The Dutch industry, exporting cocoa powder and chocolate and, particularly, cocoa butter,[1] was able to maintain its foreign trade fairly well in the inter-war period, but several firms found it advisable to transfer production abroad. Thus two big Dutch concerns set up chocolate factories on the other side of the Dutch-German frontier, while, in 1935, one of the concerns producing cocoa butter transferred its manufacturing plant to Hull (British Cocoa Mills). It seems that the preference accorded by some of the Dominions, especially Australia, to cocoa butter manufactured in Britain has been the main consideration prompting this last transfer.

A certain quantity of cocoa butter was produced before 1939 in Brazil. During the war this industry has been greatly developed, mainly by United States enterprise and with a view to supplying the United States market. This trade has been greatly aided by the reduction, in 1936, of the United States import duty on cocoa butter from 25 per cent. to 12½ per cent.[2]

The manufacture of chocolate for the domestic market has been assisted in Brazil by a high import duty and by certain tax reductions.[3]

The part which fiscal measures have played in determining location has been less evident in the case of industries utilising by-products of the major industries, but this does not mean that there has been no such influence. Of special interest in this respect are the trade relations between Britain and the Netherlands.

Before the war, as related previously, the British chocolate industry was the most important buyer of Dutch cocoa butter[4] and exported, on its part, a certain amount of cocoa cake to various countries, but particularly to Holland.[5]

Year	*Mztr.*	*Thousand francs.*
1890	6,814	2,133
1900	31,402	10,847
1910	115,555	41,409
1913	168,178	58,171
1920	162,535	96,422
1930	63,394	23,104
1935	3,746	1,223
1937	6,461	1,981

Gordian, July 25, 1939, p. 18.

1 Before the war, cocoa butter accounted for approximately 70 per cent., in value, of all exports of cocoa manufactures from Holland.

2 See page 239. The reduction was made under the United States—Netherlands Trade Agreement of that year, and Brazil as a most favoured nation participated in the reduction.

3 A decree of July 3, 1935 granted reductions on the import duties on machinery, apparatus and materials to all undertakings manufacturing cocoa preparations.

4 The British import of cocoa butter from that source amounted in 1938 to 9,548 tons. *Annual Statement of the Trade of the United Kingdom, 1935 to 1939*, Vol. II, 1940, pp. 34-35. The United Kingdom had on the other hand a certain—smaller—export of cocoa butter to the Empire, particularly Canada.

5 The *United Kingdom Trade Statistics* do not give cocoa cake as a separate item. According to the Dutch statistics, Holland imported the following quantities of cocoa cake from the United Kingdom:

1936 : 16,310 *tons.*	1938 : 14,216 *tons*
1937 : 15,154 *tons.*	1939 : 17,456 *tons*

In studying the facts underlying this exchange, attention must be drawn to the drawback of customs duty to which exporters of cocoa preparations and cocoa residue are entitled. The main factor governing the calculation of this drawback is the *weight* of the exported goods expressed as a proportion of the *weight* of the cocoa beans required for their production. This means that the lower priced cocoa cake carries on export a proportionally higher drawback than the more valuable cocoa butter. While, for instance, the average selling price for cocoa cake, with a fat content of 10 per cent., was 4*s*. 6*d*. per cwt. in 1934 to 1938, the drawback amounted to from 11*s*. 6*d*. to 15*s*. and sometimes more per cwt.[1], that is to say, it was several times as high as the selling price of the cake. The drawback on exported cocoa butter, on the other hand, at $1\frac{1}{4}d.$ per lb.,[2] represented only about one-eighth of the average selling price during the same period.

Moreover, since the amount of the drawback is determined by the weight of the beans which are needed to produce a certain amount of cocoa cake, the sum refunded to exporters is the higher the less fat is left in the cake ; for more beans are required, and more import duty has therefore been paid, to produce cake which has undergone a considerable loss of weight by the extraction of the fat down to a low percentage, than for the production of cake containing still a relatively high proportion of fat. In other words, the least valuable cake carries the highest drawback of custom duty on export.

This method of calculation is no doubt designed to encourage a high extraction of cocoa butter in this country, but it does not seem to have had this effect before 1939. Certain it is that the drawback made it more profitable for British manufacturers to export cocoa cake than to use it in further processing—for the manufacture of theobromine, for instance, and thus it played an important part in bringing about the division of labour between this country and Holland, as it existed before the war, in respect of the production of cocoa butter and of theobromine.

As was stated at the Cocoa Research Conference in 1945 : " The drawback meant that processing was being done in other countries."[3] The drawback on cocoa residue may thus be classed among the cases which Professor Gregory has in mind when he says " that a drawback may easily become itself an encouragement to exportation, and not a mere removal of a hindrance to exportation."[4]

During the war the situation changed considerably in so far as

[1] Since no figures are available of actually paid drawbacks, these figures are to be taken only as approximations. In addition to the weight and fat content, other analytical qualities of the cake are taken into account in calculating the drawback.

[2] In other words, the drawback equals the import duty on cocoa butter (one farthing more in both cases if the beans are of foreign origin).

[3] *Report and Proceedings of the Cocoa Research Conference, Col. No.* 192, 1945, p. 67.

[4] "*Tariffs : A Study in Method,*" by T. E. G. Gregory, 1921, p. 426.

the production of both cocoa butter and theobromine has been greatly developed in this country. In order to strengthen the competitive position of British theobromine manufacturers, the Finance Act of 1946 extended the right to a drawback of customs duty from cocoa cake to be exported to cocoa cake delivered to factories in this country for the manufacture of theobromine, a development which seems logical if the drawback was to be retained in its present form.[1] It remains to be seen how far this measure which, together with a customs duty of $33\frac{1}{3}$ per cent. on imported theobromine, embodies a considerable degree of assistance to British theobromine manufacturers, will remove "the encouragement to exportation" in the future. At present, it seems unlikely that the whole surplus of cocoa cake will be absorbed by theobromine manufacture in this country.

IV. Attempts at establishing Processing in the Cocoa-growing Countries, and Conclusions suggested by them

It remains to review briefly the few attempts which have been made to establish processing industries in the cocoa-growing countries, and to discuss the conclusions which they suggest as to the practicability of setting up processing on a larger scale in these countries, particularly in the principal cocoa-growing colonies.

There are two courses for increasing the amount of processing applied to a raw material in the producing countries. Either one or two further stages in treating the raw material may be added to those applied hitherto in the producing country, without, however, aiming at turning out a finished article; or full manufacturing plant may be set up, although this need not imply the introduction of all branches of production based on a particular raw material. It is not always easy to draw a line between these two courses, but in the case of cocoa the distinction is fairly clear.

The first course consists in the production of cocoa mass (also known by the trade as cocoa paste or dough) in the cocoa-growing country. This is a semi-finished product obtained by removing the shells from the beans and breaking up the nib. A certain trade in cocoa mass is to be found in the chocolate-manufacturing countries, and the article is also traded internationally, Holland being again an important exporter. The buyers are smaller chocolate manufacturers who have not the full equipment for processing cocoa beans, and makers of confectionery who use the mass for coating. Of the colonies, Trinidad has produced cocoa mass to a certain extent in small establishments and has, it appears, exported some of it to other West Indian islands. But projects to introduce the manufacture of cocoa mass on a larger scale with a view to exporting it overseas instead of the beans have not been found practicable.[2]

[1] See *House of Commons Debates*, June 19, 1946, p. 218.

[2] Memorandum on "The Exportation of Cocoa Paste and Cocoa Liquor from this Colony," by the Hon. E. Vernon Wharton, *Proceedings of the Agricultural Society of Trinidad and Tobago*, December 1938, pp. 479-482.

There seems to be little chance for such an industry, if set up in any of the cocoa-growing countries, of becoming a supplier to the principal chocolate industries of the world, since the great chocolate-producing concerns find it more satisfactory to perform the entire processing of the cocoa bean in their own establishments in order to be ensured of an unadulterated material—the preparation of cocoa mass lends itself easily to adulteration—and to sell cocoa mass themselves to the smaller chocolate-manufacturers and to confectioners. Cocoa mass is moreover taxed by a relatively high import duty in practically all the principal chocolate-manufacturing countries, and without remission or reduction of that duty, mass from the cocoa-growing countries would hardly find a market. Furthermore, it is worth noticing that the export of cocoa mass from countries that used to export a fair amount of that article—Holland, Germany, Switzerland—has tended to decline in the inter-war period. There seems to be therefore little prospect of building up a new export industry in this commodity in the cocoa-producing colonies.

Brazil is the only cocoa-growing country where an attempt has been made at setting up a modern processing industry. In 1938, approximately 1,000 tons of cocoa butter were stated to have been shipped from Bahia; about half of these went to other Brazilian ports, while Australia was the most important foreign destination, taking about one-third of the total shipments.[1] Of the 1,100 tons of cocoa cake which were exported, 600 tons went to New York. During the war, new plant was set up in Brazil and production of cocoa butter increased substantially, as is evident from the following figures[2]:

	Output.	
Year.	*Tons.*	*Cruzeiros $.*
1940	973	4,855,047
1941	2,264	15,464,007
1942	2,756	25,427,679
1943	2,099	19,705,392
1944	7,491	60,321,182

Moreover, " in the State of Sao Paulo one of the largest plants in the world for the extraction of caffeine and theobromine from cocoa cake was set up to operate with machinery made in Brazil."[3] The entrepreneur is the Cia. Monsanto do Brasil, a subsidiary of the United States Monsanto concern. All the theobromine manufactured in this plant goes to the United States, who has also taken a large part of the Brazilian output of cocoa butter during and since the war.[4]

1 *Gordian*, May 25, 1939.
2 Supplied by the Department of Overseas Trade.
3 " Brazil. Review of Commercial Conditions." *Department of Overseas Trade*, December 1944, p. 24.
4 In 1946 the United States imported 189,499 lb. of theobromine, practically all from Brazil, while in 1938 only 5,000 lb. were imported, mainly from Switzerland. The import of cocoa butter was 3,177 tons in 1946, Brazil again being the only important supplier, as against only 4 tons in 1938, which came mainly from Holland.

But it is doubtful whether Brazilian cocoa butter will be able to hold the position acquired in the United States market in recent years. There is a strong movement among United States producers of cocoa butter to have the import duty, which was halved in 1936, raised to its former rate of 25 per cent. or even higher. The future of the Brazilian industry will be greatly affected by the decision to be made in this respect.

The manufacture of chocolate and chocolate confectionery for the domestic market is carried on in Brazil on a relatively small scale considering the size of the country and its population, though it is more developed than in the two other South American cocoa-growing countries—Venezuela and Ecuador.

Trinidad is the only colony where the setting up of plants manufacturing chocolate for both the domestic market and for export has been seriously considered, but the results of enquiries made on similar experiments in other tropical countries, i.e. Ceylon, Porto Rico, Cuba, and Venezuela, were so discouraging that the project was not proceeded with.[1]

Extraction of cocoa butter by native methods was encouraged during the war in the Gold Coast with a view to putting to economic use some of the cocoa beans for which no shipping space was available. Roasted beans were therefore distributed by the Government to native millers and the product was taken over at a fixed price by the West African Produce Control Board. But the methods used proved so wasteful—only 50 per cent. of the fat was extracted and the residue could not be utilised—and the product turned out was so uneven, that the experiment was discontinued after two seasons.[2]

To sum up, it seems unlikely that the development of a chocolate industry in the tropical colonies is a feasible proposition. Investigation and experiment would therefore have to concentrate on the practicability of setting up merely oil-extracting plant in West Africa. This is the more so, since cocoa butter production requires no further ingredients, such as sugar, milk, or flavouring matter, and an economy in weight of from 50 to 60 per cent.—according to the degree of extraction—would be effected if cocoa butter, instead of cocoa beans, were shipped. This economy would, however, be partly offset by the necessity of providing more expensive storage facilities and containers than are required for the beans. Furthermore, as has been shown previously, the extraction of the butter

[1] A Committee which had been set up to examine the practicability of establishing in Trinidad a chocolate factory as a measure of assistance to cocoa growers came in 1932 to the following conclusion: "The Committee is satisfied that the manufacture of chocolate would have to be confined absolutely, as is the case in Porto Rico, Cuba, Venezuela, and other neighbouring tropical countries, to such factories producing for local consumption only," *Trinidad Council Paper No. 49*, of 1932, p. 4. It seems, however, that even production for the domestic market has not been established on any appreciable scale. The manufacture of cocoa goods is not among the industries recommended for Government assistance by the West India Royal Commission of 1938-39.

[2] 5 tons of beans yielded only 1 ton of butter, whereas in this country only 2½ tons of beans are required for obtaining 1 ton of butter.

from the bean leaves a residue—cocoa cake—which can be used for various purposes, namely, cocoa powder, in the production of theobromine, as cattle food, or as fertiliser. Without utilisation of the residue, or at least of part of it, in a commercially profitable manner, a colonial industry would be extremely wasteful compared with the methods applied in industrially advanced countries. The present organisation of processing allows manufacturers, within certain limits, to choose between different uses of the cocoa cake according to the economic circumstances at the time. It seems doubtful whether the same degree of flexibility could be given to a colonial industry.

From a technical and most likely also from a commercial point of view, the production of theobromine appears easiest to combine with the extraction of cocoa butter. It is worth mentioning in this connection that modern methods of production in both industries are highly mechanised and require a very small labour force. The sums accruing to the respective colonies in wages would not, therefore, be considerable, while a number of skilled technicians, chemists, and foremen would have to be imported. Nor are the industries such as to stimulate further industrial development. No great advantages for the colonies could therefore be expected from their establishment.

The degree to which a colonial industry concentrating on the extraction of cocoa butter would affect the present organisation of the cocoa-processing industries would depend on several factors. If a relatively small proportion of the cocoa crop were to be processed in West Africa, the output of cocoa butter might easily be absorbed by the expanding chocolate industries in this country and in the British Dominions where, as a product from Empire territories, it would enjoy preferential customs treatment.[1] If, on the other hand, production on a large scale would be successfully introduced, the pre-war international division of labour might be considerably modified. Not only would the Dutch cocoa butter industry lose its most important foreign market, but the possibility for British chocolate manufacturers of exporting their redundant cocoa cake to Holland under the present advantageous system of assessing the drawback of customs duty would also be reduced. Another result would be proportionally smaller purchases of West African cocoa beans by the Dutch industry—before the war the fourth largest customer of both the Gold Coast and Nigeria. But this last result might be avoided should an expansion take place in the use of cocoa and especially in the consumption of chocolate for which there is, as has been shown, still ample room in a good many countries.

[1] That is to say, of the Dominions, only Australia and Canada allow a preferential duty on Empire cocoa butter; while South Africa levies a flat rate on all cocoa butter without regard to origin, and New Zealand admits cocoa butter free of duty.

TABLE I

WORLD EXPORTS OF COCOA BEANS FROM PRODUCING COUNTRIES.*

Countries.	Metric Tons.					Percentages of total exports.				
	1938	1928	1918	1908	1898	1938	1928	1918	1908	1898
Gold Coast	261,557	223,339	67,404	12,946	188	37·0	43·5	24·6	6·7	0·2
Nigeria	97,542	49,950	10,383	1,388	35	13·8	9·7	3·8	0·7	0
Ivory Coast	52,719	14,515	420	3	—	7·5	2·8	0·2	0	—
French Cameroons	27,677	6,699	2,575	2,447	209	3·9	1·3	0·9	1·3	0·2
San Thomé	12,729	14,638	17,332	28,560	9,945	1·8	2·9	6·3	14·8	11·5
Rest of Africa	17,128	16,760	6,920	3,085	902	2·4	3·0	2·5	1·6	1·1
AFRICA	469,352	325,901	105,034	48,429	11,279	66·4	63·2	38·3	25·1	13·0
Brazil	125,000	72,395	41,865	32,956	12,943	17·7	14·1	15·3	17·1	14·9
Dominican Republic	28,220	19,302	18,839	19,005	3,993	4·0	3·8	6·9	9·9	4·6
Ecuador	18,451	22,961	38,416	32,119	21,089	2·6	4·5	14·0	16·7	24·3
Venezuela	17,000	19,969	19,762	16,303	9,572	2·4	3·9	7·2	8·5	11·2
Trinidad	19,504	26,312	26,593	21,370	11,462	2·8	5·1	9·7	11·1	13·2
Rest of America	21,275	20,330	17,297	16,847	13,011	3·0	4·0	6·3	8·8	15·0
AMERICA	229,450	181,264	162,792	138,600	72,070	32·5	35·4	59·4	72·1	83·2
ASIA AND PACIFIC	8,094	7,234	6,374	5,468	3,451	1·1	1·4	2·3	2·8	3·8
GRAND TOTAL	706,896	514,399	274,200	192,497	86,800	100	100	100	100	100

* *Figures from " Gordian," April* 25, 1939, pp. 186-187.

TABLE II

EXPORTS OF COCOA BEANS FROM COLONIES

(Metric Tons)

Colony.	1938	1928	1918	1908	1898
Gold Coast	261,557	223,339	67,404	12,946	188
Nigeria	97,542	49,950	10,383	1,388	35
Ivory Coast	52,719	14,515	420	3	—
Cameroons	27,677	6,699	2,575	2,447	209
Fernando Po	7,000*	8,664	4,220	2,267	800
San Thomé	12,729	14,638	17,332	28,560	9,945
Togo	7,628	6,317	1,576	84	—
Belgian Congo	1,200*	850	743	612	—
Madagascar	300*	125	81	22	2
Other African	1,000*	804	300	100	100
AFRICA	469,352	325,901	105,034	48,429	11,279
Trinidad	19,504	26,312	26,593	21,370	11,462
Grenada	4,000*	4,646	5,525	5,108	4,200
Jamaica	2,300*	2,388	3,013	2,694	1,000
Santa Lucia	300*	559	809	615	471
Martinique	200*	392	575	530	534
Guadeloupe	100*	559	1,158	744	635
Dominica	150*	260	215	488	300
Surinam	10*	251	2,468	1,699	2,830
Other American	100*	175*	150*	400*	50*
AMERICA	26,664	35,542	40,506	33,648	21,482
Ceylon	3,704	3,794	4,014	2,836	2,434
Dutch East Indies	1,590*	1,117	796	2,278	917
Samoa	800*	974	808	204	—
Others	2,000*	1,349	756	150	100
ASIA AND PACIFIC	8,094	7,234	6,374	5,468	3,451
GRAND TOTAL	504,110	368,677	151,914	87,545	36,212
Colonial Exports as Percentages of World Exports	71·4	71·7	55·4	45·5	41·7
Exports from British Colonies	370,667	312,456	118,556	47,770	20,215
As Percentages of World Exports	52·5	60·9	43·2	24·8	23·3

* *Estimate.*

TABLE III

WORLD IMPORTS OF COCOA BEANS INTO CONSUMING COUNTRIES*

Countries.	Metric Tons.					Percentages of total imports				
	1938	1928	1918	1908	1898	1938	1928	1918	1908	1898
Great Britain	96,174	56,457	62,233	21,052	14,435	15·2	11·8	19·4	12·7	16·2
Germany	79,086	75,361	—	34,352	15,860	12·5	15·7	—	20·6	17·8
Netherlands	74,781	45,800	2,385	15,821	13,900	11·8	9·6	0·7	9·5	15·6
France	42,426	34,085	41,496	20,445	17,445	6·7	7·1	13·0	12·3	19·5
Belgium	10,112	6,116	600	4,554	1,425	1·6	1·3	0·2	2·7	1·6
Switzerland	9,204	8,791	18,059	5,821	3,186	1·5	1·8	5·6	3·5	3·6
Russia	11,000	4,755	700	2,588	1,430	1·7	1·0	0·2	1·6	1·6
Others	70,647	53,098	18,429	14,723	8,548	11·4	11·1	5·8	8·9	9·1
EUROPE	393,430	284,463	143,902	119,356	76,229	62·4	59·4	44·9	71·8	85·0
U.S.A.	200,109	163,161	156,845	42,615	11,573	31·8	34·0	48·9	25·9	13·1
Canada	11,997	8,521	8,706	1,077	187	1·9	1·8	2·7	·7	0·2
Argentine	5,529	4,617	2,841	895	500	0·9	0·9	0·9	0·5	0·6
Others	4,100	10,577	1,349	300	90	0·6	2·2	0·5	0·2	0·1
AMERICA	221,735	186,876	169,741	44,887	12,350	35·2	38·9	53·0	27·3	14·0
Australia and New Zealand	11,000	5,170	2,300	847	437	1·7	1·1	0·7	0·5	0·5
Philippines	1,500	1,898	3,446	700	400	0·2	0·4	1·1	0·4	0·5
South Africa	2,000	202	342	20	—	0·3	0	0·1	0	—
Others	1,200	1,214	508	65	20	0·2	0·2	0·2	—	0
TOTAL	15,700	8,484	6,596	1,632	857	2·4	1·7	2·1	0·9	1·0
GRAND TOTAL	630,865	479,823	320,239	165,875	89,436	100	100	100	100	100

* *Figures from "Gordian," April* 25, 1939, pp. 186-187.

NOTES

Utilisation of Linseed Straw.—In view of the efforts which are being made in this country and in the Empire to increase the production of linseed oil, it is probable that there will be fairly large quantities of linseed straw available. Up till recently, the straw has been a waste product, and although the straw contains fibre, no use had been found for it. The most likely uses of the straw are the following: (1) as a paper-making material; (2) as a source of cellulose for rayon manufacture, or for other purposes; (3) as a raw material for thread, twines, ropes, etc.

Linseed is harvested and threshed for its seed in much the same manner as are other crops. The straw as baled contains about 30 per cent. of chaff, leaves, dirt, etc. The yield of straw varies considerably according to the district and the season, but in the United States a yield of ¾ ton of straw per acre is considered a good average.

(1) As a Paper-making Material

From the paper-making point of view the important constituents of the straw are the long bast fibres and the woody core of the stem, and together these account for about 90 per cent. of the weight of the straw. The bast fibres occur in the form of a ring of fibre bundles situated in the inner cortex, and encircle the stem. The proportion of bast fibre in the stem is on the average 15 to 20 per cent. The woody core constitutes about 70 to 75 per cent. of the weight of the entire straw. When broken into small pieces and separated from the bast fibre the woody core is known as shives.

In chemical composition and in fibre length the bast fibre and shives differ considerably. The bast fibre contains about 72 per cent. of cellulose as compared with only 57 per cent. in the shive, and the shive contains higher percentages of lignin and of pentosans, as may be seen from the following table:

Chemical Composition of Linseed Straw
(All figures are on a moisture-free basis)

Material.	Total Cellulose (Cross & Bevan).	Lignin.	Pentosans.		Solubility.			Ash.
			Total	In Cellulose.	In Alcohol-benzene.	In hot water.	In 1 per cent. NaOH.	
	per cent.	*per cent.*	*per cent.*	*per cent.*	*per cent.*	*per cent.*	*per cent.*	*per cent.*
Linseed straw	52·6	23·8	18·3	7·6	3·5	11·0	32·9	4·8
Bast Fibre therefrom	71·9	10·1	6·0	2·4	2·3	11·1	29·2	4·7
Shives therefrom	57·0	27·9	25·6	11·4	6·5	5·1	24·2	3·5

As will be seen from the following table, in fibre dimensions

the difference between the bast fibre and the shive is even greater than in their chemical composition :

Fibre Dimensions of Linseed Straw

	Length (*mm.*).			Width (*mm.*).		
	Minimum.	*Maximum.*	*Average.*	*Minimum.*	*Maximum.*	*Average.*
Bast . . .	5·0	64·0	—	0·009	0·013	0·011
Shive . . .	0·16	0·42	0·20	0·010	0·039	0·019

The shive, therefore, closely resembles the hardwoods while the bast is a much purer form of cellulose. The shive, with its short fibre length, is of poor value for paper-making while the bast fibre has a high potential value, and in view of the difference in their nature, pulping conditions suitable for one are inevitably unsuitable for the other.

For paper-making, therefore, the utilisation of the straw can follow two methods, either :

(*a*) The long-fibred bast may be separated from the shive by mechanical means such as are employed commercially in the United States for the manufacture of upholstery tow. The bast fibre may then be used for high-grade papers and the short-fibred shive pulped separately and employed for purposes for which fibre length is not of importance. Although on theoretical grounds this is no doubt the ideal method of making use of the special properties of the raw material, serious practical difficulties arise ; or

(*b*) The whole straw may be pulped.

(*a*) *Long-fibred bast*

The use of the bast fibre from linseed straw for paper-making has increased enormously in the United States in recent years. In 1937 about 5,200 tons were used, in 1940 about 147,200 tons, and in 1945 about 360,000 tons. The fibre is used chiefly for cigarette paper, but is also used for carbon paper, air-mail letter paper and thin book paper, etc., where a thin, strong paper is required. Although some of the straw is processed in mills, a considerable quantity is processed by means of portable decorticating machines which are moved from farm to farm. In the machines the straw is passed between fluted rollers under pressure by coil springs, which break the inner woody portion of the stems and separate it from the outer bark. The woody portion is beaten away by beaters and then removed, with the leaves, chaff, dirt, etc., by means of air suction. This reduces the bulk of the straw to about half its original volume, and helps to save the cost of baling, trucking and transport.

There is now a well-established market for flax straw fibre in the United States, and provided suitable straw is available at a reasonable price the demand will no doubt continue, although the chief problem to be solved is still the economical production and handling of the straw.

(b) Whole Linseed Straw

Owing to the difficulty of obtaining the bast sufficiently free from shive to obtain the best results, and the low value of the residual shive, it is probable that in the United Kingdom attention would be concentrated on the use of the entire linseed straw. Such a method of utilisation would have the additional advantage of not needing the provision of any special equipment for the separation of the bast fibre from the straw.

Considerable work has been done at the United States Forest Products Research Laboratory on the pulping of linseed straw and the following is a review of the results obtained.

Medium-quality wrapping papers can be made from the whole straw by the sulphate process. The chemical consumption is about double that for wood. Papers that could be classified as equivalent to medium-grade wood pulp bonds were also manufactured. The most satisfactory results with this latter type of paper were obtained by the employment of the following cooking conditions:

Cooking liquor	$NaOH$ 17·4 per cent., Na_2S 4·3 per cent. } on the weight of the moisture-free *undusted* straw
Volume of cooking liquor per 100 lb. of moisture-free straw	60 gallons
Time to reach maximum temperature	2 hours
Time at maximum temperature	5 ,,
Maximum temperature	155° C.

Yield of pulp: 42·6 per cent. on weight of *undusted* straw.

The entire linseed straw dusted prior to cooking has been found to be suitable for the production of greaseproof and tissue papers. The maximum yield of pulp of the desired properties amounted to 46 per cent. of the weight of the dusted straw. It should be pointed out, however, that the loss in dusting is high, often amounting to over 30 per cent., which means that the yield obtainable in terms of the original raw material would be much lower than is the case with the woods which are commercially utilised for the manufacture of pulps. The cooking conditions employed in the preparation of the pulp mentioned were as follows:

Cooking liquor	$NaOH$ 19·1 per cent., Na_2S 4·4 per cent. } on the weight of the moisture-free *dusted* straw
Volume of cooking liquor per 100 lb. of dusted straw	53 gallons
Time to reach maximum temperature	2 hours
Time at maximum temperature	8 ,,
Maximum temperature	160° C.

Yield of pulp: 46 per cent. on weight of *dusted* straw.

Although this pulp yielded a satisfactory greaseproof paper, the pulps were not easily bleached, and it is also stated that excessively prolonged beating is required to hydrate the pulp.

Experiments have also been made in the use of the straw for the manufacture of boards, but the results suggest that both boards made by the lime process from linseed straw alone, and from mixtures of linseed straw and oat straw, were inferior to boards made solely

of oat straw. Lime, however, is not an ideal chemical for the digestion of linseed straw since it does not readily soften the woody shive. When digested with a mixture of caustic soda and sodium sulphide the boards produced had an increased folding strength, and although not stiff enough for corrugated board, were of good appearance, and it was suggested that they might find an outlet for purposes where a flexible board was required.

Preliminary experiments have also indicated that linseed straw is promising for the manufacture of types of board such as leather board and insulating board.

In 1917, the Imperial Institute carried out trials with the entire stalks of linseed straw from Rhodesia with a view to ascertaining whether they were suitable for paper-making. By the soda process the following results were obtained:

Caustic soda used.		Conditions of boiling.		Parts of soda consumed by 100 parts of stalks.	Yield of dry unbleached pulp expressed on the material as received. *per cent.*
Parts per 100 parts of stalks.	Parts in 100 parts of solution.	Time in hours.	Temperature.		
18	4	5	150° C.	14·5	44

The pulp yielded a fairly strong paper of medium brown colour, but it was found very difficult to bleach, even when much larger quantities of bleaching powder were used than could be used on a commercial scale, and even with the use of such large quantities the colour was not greatly improved. The length of the ultimate fibre in the paper was about 2·0 to 4·0 mm.

Trials were also made using the sulphite process, with the following results:

Trial No.	Strength of sulphite liquor: 100 parts contained the equivalent of		Conditions of boiling.		Yield of dry unbleached pulp expressed on the material as received. *per cent.*
	Lime (CaO).	Magnesia (MgO).	Time in hours.	Pressure and Temperature.	
1	0·7	0·3	8	5 atmospheres at 150° C.	46
2	0·7	0·3	3	3 atmospheres at 145° C.	45

As will be seen, the yield by the sulphite process was about the same as by the soda process, but the pulp was of much better colour, and could be readily bleached to a fairly satisfactory tint.

At the same time the Imperial Institute also made trials with the tow obtained after crushing the stalks between rollers and beating and thrashing. The paper obtained was tougher than that from the whole stems, but was difficult to bleach, and the improvement in quality was considered too slight to make it worth while to separate the tow from the shive for paper-making purposes.

Trials with the shive alone yielded a paper which was inferior in strength and colour to both that obtained from the tow and that from the entire stems. Moreover, it could not be bleached. The pulp was only suitable for very low grade paper, and the conclusion was reached that it might prove unworkable unless it were mixed with a longer-fibred material.

The present position as regards the utilisation of linseed straw for paper-making, therefore, appears to be that:

(1) Unless special machinery is used to separate the bast fibre from the shive, as is done in the United States, it is not possible to make high-grade paper from the bast fibre comparable to that obtainable from linen rags.

(2) Unless such special machinery is used, the bast fibre contains a proportion of shive and requires a correspondingly more drastic treatment which lowers the strength of the resulting pulp. Such pulps, generally, may be considered as similar in quality to sulphite pulps, suitable for medium-grade bonds, greaseproofs, tissues, etc.

(3) The shive is lignified and of very short fibre length. It requires digestion similar to that employed for wood, and the pulp is of low value and only suitable for use as a filler in book paper.

(4) The whole straw can be digested by the sulphate process to yield a medium-grade wrapping paper. Papers equivalent in quality to medium-grade wood-pulp bonds can also be prepared, and, by digestion of the dusted straw, pulps suitable for greaseproofs and tissues may be manufactured. Losses in dusting the straw prior to cooking are, however, very considerable so that, as regards these latter products, the yield of the raw material is very low.

The whole straw may also be made into boards, for which purpose digestion with a mixture of caustic soda and sodium sulphide is to be preferred to the use of lime.

(5) While other materials are available in sufficient quantities and at reasonable prices paper-makers are not likely to be interested in linseed straw. If, however, such other supplies were cut off, paper-makers here could no doubt by research and experiment find suitable methods of making use of the straw so that it could take the place, to some extent at least, of materials which are at present being used.

(2) As a Source of Cellulose for Rayon, or for other Purposes

In India, investigations have been made recently with linseed straw with a view to its possible use as a raw material for rayon manufacture. The conclusion reached, however, was that unless the straw was likely to be available at much lower prices, it was not likely to be a promising source of supply of alpha-cellulose. The following table, taken from the *Journal of Scientific and Industrial Research, India*, (1944, **2**, No. 5, p. 289), shows the treatment given and the results obtained:

Autoclave Treatment given.

Pressure.	Duration.	Alkali concentration at the beginning—per cent. on weight of material.	Bath ratio.	Available Cl_2 consumed—per cent. on weight of material.
lb.	*hours.*			
80	9·0	Caustic soda 20·0	1 : 5	4·56

Results.

Whiteness.	Ash in raw material.	Yield of pulp on dry basis.	Alpha—cellulose in pulp.	Ash in pulp.	Alpha—cellulose in dry raw material.
	per cent.	*per cent.*	*per cent.*	*per cent.*	*per cent.*
White	4·09	30·85	71·61	0·24	22·09

(3) As a Raw Material for Thread, Twines, Ropes, etc.

As regards the use of the fibre from linseed straw for string, although from time to time suggestions have been made that it could be used for ropes, twines, etc., as far as the Imperial Institute is aware, it has never been used on a commercial scale. One reason for this is no doubt the fact that in normal times the fibre would have to meet the competition of the more established fibres which are used for these purposes. Another reason is that the fibre varies considerably according to the variety of linseed and also probably according to the time at which the linseed is sown. Moreover, in removing the seed pods from the straw, the fibre is often damaged by the beating given in the threshing process.

Experiments have been made in India with the fibre obtained by mechanical means and also by retting. The Department of Commerce and Industries, United Provinces, made trials in 1941. The fibre obtained by mechanical means was found to be rough and of poor spinning quality. That obtained by retting, however, was found to be quite strong and suitable for canvas, ropes, fine quality twines and thread, and for the production of cottonised fibre. Since the ultimate fibres of the bast fibre are about 1 in. in length, and could be obtained by chemical means it has been suggested that the fibre could be "cottonised" and spun on its own or with cotton, but it has never been used on a commercial scale as far as the Imperial Institute is aware.

According to one report, one firm in this country carried out experiments in 1934-35 in the spinning of cut fibre from prepared Canadian green linseed straw. The experiments showed that good, strong, even and soft yarns could be produced from the fibre.

Retted Indian linseed straw yields on an average about 7 per cent. of long fibre (12 to 15 in.), 23 per cent. of short fibres or tow, 46 per cent. of woody core pieces, and about 24 per cent. of waste. By hand separation, which is costly and laborious, the yield of long fibre may be increased to as much as 12 per cent. The length of the long fibres depends on the length of the original stem.

Provided the fibre can be properly prepared, therefore, it would

probably be suitable for twines, threads, etc. The tow might be suitable for upholstery purposes. The utilisation of the fibre, however, would be dependent largely on the cost at which it could be produced in this country.

Conclusions

In view of the large quantities of the straw which are likely to be available in the future, it seems desirable that some use should be made of it. It is possible that paper-makers here might be more interested in it now, in view of the shortage and difficulty of obtaining other materials, and, if so, paper-making would probably be the best use for it. In the United Kingdom cereal straw was used on a considerable scale during the war for paper-making, and the experience gained in collecting it from the farmers and sending it to the paper-mills should be useful in the case of linseed straw. Paper manufacturers here could no doubt find a suitable method of digesting the straw. How far it could be used for general paper purposes, however, could only be ascertained by experimental work by the paper-makers. Cost would, of course, be one of the factors determining the extent of its possible use. The chief difficulty, however, is likely to be the availability of digesters. Firms at present using esparto and cereal straw for paper manufacture would, of course, be able to digest the linseed straw. In the case of firms who rely mainly on imports of wood pulp, however, it would entail the acquisition of digesters and even assuming that it is possible to obtain the plant within a reasonable time and assuming that space, etc., are available, the use of linseed straw would necessitate fundamental changes in their manufacturing technique.

As regards its use for twines and threads, it would be a good plan in the first place to have trials made in retting, preparing and spinning the fibre. Only small quantities of fibre, about 10 cwt. to 1 ton, would be necessary for the purpose, and such tests would serve to show whether the fibre is suitable for string or other purposes.

In some countries the stems are dew-retted and the fibre is extracted for local use as twine, thread, etc. The difficulty with dew-retting, however, is the large area required for spreading the stems while they are being retted. In Turkey, after the seeds have been separated for oil purposes, the sheaves are collected and retted. Retting in water is preferred, but if water is not available the stalks are dew-retted. Generally the fibre from water-retting is found to be harder than the dew-retted. The retted stalks are then dried in the open, where possible, but where fog or rain coincides with the retting season the village baking ovens are used for drying. This method, however, sometimes lowers the elasticity of the fibre since it may scorch it and render it brittle. Breaking of the stalks is done on a primitive hand machine and the fibre is then twisted into strands, passed through a coarse wooden comb

and then softened in a stone mill. It is afterwards combed with a finer comb and brushed with a stiff bristle brush. Finally the fibre is spun either on a distaff or on a spinning wheel.

The suitability of this straw or fibre for the purposes discussed above will be related to the varieties of linseed which are selected for cultivation in this country. The yield of seed to be obtained is obviously of prime importance, but on the other hand, if it is hoped to utilise the fibre from the straw as well, it might be more profitable to grow a variety of flax which is intermediate between a seed flax and a fibre flax, in order to obtain a fairly good yield of both. Normally, of course, plants grown for fibre, however, are harvested before the seed matures.

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R. H. K.

Work of the Department of Agriculture, Nigeria.—At the close of 1945 Mr. M. Greenwood, Senior Specialist, Department of Agriculture, Gold Coast, visited Nigeria to study and report on such parts of the work of the Nigerian Department of Agriculture as would be of interest and instruction to his own Department in framing plans of research and development. As a result of this study it was hoped in the matter of future research to minimise wasteful duplication of effort in the West African Colonies and as regards the development of internal markets to make those in each Colony aware of the work done in the other. The results of this tour of investigation—*Report on a Visit to Nigeria, November-December*, 1945—have now been printed and form a most valuable review of some of the activities of the Nigerian Department, with useful particulars concerning those of the Gold Coast. Mr. Greenwood is well qualified for his task, as he served for a period in Nigeria before proceeding to the Gold Coast, and in 1938 renewed his Nigerian experiences at the Third West African Agricultural Conference.

The report, which extends to some 45 pages, is filled with a miscellaneous but extremely valuable collection of data, including scientific, experimental, cultural and economic information. The

amount of experimental work in progress is impressive. It is interesting to note that the germination problem with oil palm nuts is still far from solved and that the need for some fundamental research in this direction is considered. The rate of expansion in mixed farming in the Northern Provinces is limited by the large number of bulls that must be trained annually to replace wastage in addition to those required to supply new farmers, and by the disease situation, particularly acute pleuro-pneumonia. Problems in connection with the maintenance of soil fertility receive extensive treatment. The four-course green-manure rotations which have been under study at Ibadan during the past 25 years are described; a rotation based on green-manuring which is suited to the farmer has still to be worked out, but its evolution seems to be proving a most intractable problem. The proper and economic use of fertilizers will provide a wide field for future experiment and study.

Work with livestock has expanded. Dried blood meal when fed at the rate of 4 oz. per day has given excellent results with unthrifty calves and fed to fattening pigs at 1 oz. per day in controlled feeding trials at Shika, a weight increment of 117 per cent. over controls has been obtained (2 oz. per day gave no further increase) and the fattening period (to 180 lb.) has been reduced from 44 to 28 weeks. Sheep and goat husbandry does not appear to have made great progress in Nigeria, and the sheep flocks were judged to be nowhere as flourishing as those of the Central Provinces of the Gold Coast which are fed mainly on Centrosema. The difficulties of organising a trade in fresh milk outside the producing areas are discussed, butter (together with clarified butter fat) is considered to be a more promising product for the Northern dairies. Work on pastures and fodders seems to be in the initial stages, and that with poultry is not mentioned.

During the war years there has been a spectacular development of rice cultivation in Nigeria. It is hoped to maintain an export of Nigerian birdseye chillies. Although the slab-sugar industry of the Northern Provinces is shown not to be competitive with imported crystal sugar, this material finds an outlet as a sweetmeat reaching consumers to whom sugar might otherwise be unknown. The industry producing exclusively for local trade seems firmly established. The production of biltong, dried blood and bone ash is described. As regards the Gold Coast, it is clear that the probable output of bananas, should the pre-war export trade be revived, will not be sufficient to obtain the service of special banana boats. The report concludes with a reference to the initiative shown during the war by Mr. J. K. Ladipo, proprietor of the Lissabi Mills, Lagos, and a former African member of the staff of the Nigerian Agricultural Department, in designing and assembling a wide variety of equipment needed by his mills from such scrap metal as was locally available at the time.

It is hoped that this note will serve to draw attention to a

report which seems to be of more than usual interest among similar studies. It is perhaps a little unfortunate that this report is not issued for sale, though, for instance, it is understood to be available for consultation in many libraries in this country. Admittedly demand might be limited but this report merits wide attention.

E. H. G. S.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

THE TERPENES. Vol. I. THE SIMPLER ACYCLIC AND MONOCYCLIC TERPENES AND THEIR DERIVATIVES. By J. L. Simonsen. Second Edition Revised. By J. L. Simonsen, D.Sc. (Manc.), F.R.I.C., F.R.S., and L. N. Owen, B.Sc., Ph.D. (Birm.), F.R.I.C. Pp. 16 + 479, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Cambridge University Press, 1947.) Price 30*s.*

Those familiar with the first edition, published in two volumes in 1931 and 1932, of Dr. Simonsen's *The Terpenes* will be pleased to hear of a second edition of this excellent treatise on the chemistry of the terpenes and related compounds. Volume I of this new edition has recently appeared and a revised and enlarged edition of the original second volume is in course of preparation.

In scope and general layout the volume now under notice is similar to the earlier one and the book deals, in two parts, with the chemistry of the simpler acyclic terpenes (Part I) and the monocyclic terpenes (Part II) and the alcohols, aldehydes, ketones and oxides derived from them.

The work has been thoroughly revised and brought up to date, as far as possible, by the inclusion of published information up to the end of 1945, and later in some instances. Three compounds, androl, zierone and origanene, figuring in the first edition are not now included, presumably because their identity is not considered sufficiently well established, but lavandulol, safranal, angustione, dehydroangustione, leptospermone, cryptone, piperitenone and isopiperitenone have been introduced, and additional information on a number of the compounds retained in the new edition is now provided.

The book, which is extremely well printed, is furnished with indexes of authors and subjects, and will appeal to all organic chemists, whilst those working in the field of terpene chemistry will find it invaluable.

H. T. I.

THE COOPERAGE HANDBOOK. By Fred Putnam Hankerson. Pp. vi + 182, $8\frac{1}{2} \times 5\frac{1}{2}$. (Brooklyn, New York: The Chemical Publishing Co., Inc., 1947.) Price \$3.75.

As the author mentions in his Foreword, although barrels have been in use for two thousand years, and although millions of them are made each year, the information published about them is very scattered and scanty. It is the aim of this book to gather together under one cover as much information as is available on cooperage, handling, storing, car-loading, lining, opening and closing and other technical subjects relating to barrels. The author has succeeded in his aim, and this book should be of inestimable value to those who ship or buy products of any description in wooden barrels.

The book has six chapters, entitled respectively: The Wooden Barrel in History; Cooperage in America; The Tight Barrel; The Slack Barrel; The Beer Barrel; and General Barrel Information. An excellent feature of the book is the large number of photographs and drawings which illustrate the points made in the text, such as the correct way to handle barrels; how they should be assembled, stored, opened or closed. If these operations are not done properly, considerable financial loss can be incurred, not only by the loss of the material due to the faulty container, but also in the replacement of barrels. Those familiar with the shipment of rum, for example, will know the high costs incurred in replacing puncheons, which, although bought new, are found to be faulty on arrival at their destination. The faults are due, more often than not, to faulty assembling and handling of the puncheons in the countries from which the rum is shipped. A study of the chapter on Tight Barrels will give the shipper much assistance in tracking down the cause of faults and remedying them.

The three chapters on Tight Barrels, Slack Barrels and Beer Barrels contain a mass of information on the best woods for containers for different materials; the handling, loading, filling, storing, closing, opening and selection of lining materials, together with the specifications for various types of barrels.

The final chapter gives general information on the measurements and capacities of barrels, the tools used in cooperage, with illustrations, hints for loading barrels for shipment by rail, which are also excellent illustrated, and finally, a glossary of cooperage terms.

This book contains much valuable information of a practical nature and is to be highly recommended to all those interested in the transport or storage in wooden barrels of all types of materials.

R. H. K.

METHODS OF VITAMIN ASSAY. Prepared and edited by The Association of Vitamin Chemists, Inc. Pp. xviii + 189, 9×6. (New York and London: Interscience Publishers, Inc., 1947.) Price 21*s*.

The Association of Vitamin Chemists, which is responsible for

the production of this work, was organised in 1943 to promote exchange of information on and improvement of methods of vitamin assay.

The scope of the book is limited and only methods that have been successfully applied to a variety of materials by committee members is included. After the first chapter, which deals with the very important operation of sampling, chapters 2 to 7 are devoted to the assay of vitamin A, Carotene and vitamins B_1, B_2, Nicotinamide, and C, while chapter 8 lists references to other vitamin assays, i.e., D, E, K, and various B group factors.

The book is well compiled and the various methods given whether chemical or microbiological are fully described, giving the analyst a very clear picture of the present position of vitamin assay and pointing out any difficulties that might arise. Each chapter gives a useful list of applications of the various methods and references to the literature cited appear after each section.

This should prove a very useful manual for the analyst concerned with vitamin determinations.

R. W. P.

Practical Emulsions. By H. Bennett. Second Edition. Pp. xv + 568, $8\frac{1}{2} \times 5\frac{1}{2}$. (Brooklyn, N.Y.: Chemical Publishing Co., Inc.; London: Chapman & Hall, Ltd., 1947.) Price $8.50.

Numerous books are obtainable dealing with emulsions from a theoretical aspect but there are very few which deal specifically with the practical side and this book should help to fill that gap.

The second edition of this work has been completely revised and enlarged containing additional sections on partial fatty acid esters of polyhydric alcohols and their uses in various industries, the use of soap, lecithin and pectin as emulsifying agents and on surface active germicides. The book is divided into three parts: 1, General information. 2, A symposium consisting of papers on emulsifying agents and emulsions. 3, Typical formulae for numerous technical emulsions. A comprehensive list of references is given at the end of each chapter.

This work should prove most useful to the technical worker interested in emulsions. In it is contained information on methods of preparation, conditions, types for any particular purpose and various difficulties likely to be met with. The printing is of a high standard.

R. W. P.

Annual Review of Biochemistry. Edited by J. Murray Luck. Vol. XVI, 1947. Pp. xi + 740, $8\frac{3}{4} \times 6$. (California: Annual Reviews Inc., Standard University P.O.) Price $6.

This volume constitutes a useful summary of the present position in various fields of Biochemistry. Although an American publication, some of the various sections have been written by workers

from other countries. This resumption of international co-operation is both hopeful and encouraging in a world that is undergoing the process of post-war rehabilitation but very slowly.

Altogether there are 25 chapters covering such subjects as steroids, antimalarial drugs, nutrition, vitamins, antioxidants, proteolytic enzymes, isotopes employed in biological research, and protein and animo acids. Each chapter is succeeded by a large list of references of literature cited and a comprehensive index of authors and subjects appears at the end of the work.

Printed under difficult conditions, the Americans are to be congratulated on producing such a useful work.

R. W. P.

THE MICROSCOPE: ITS THEORY AND APPLICATIONS. By J. H. Wredden, F.R.M.S. Pp. xxiv + 296, 10 × 7. (London: J. & A. Churchill, Ltd., 1947.) Price 21*s*.

When the author of a scientific work has a wide knowledge and a long experience of his subject and this is coupled with a flair for putting his specialised knowledge into simple language, the result must be a book of more than usual merit. This treatise fulfils these conditions and must therefore rank as an excellent explanation of the microscope, its theory and application.

It is obvious that the author's aim is to impart his knowledge and experience to others because he recognises the fundamental need for a sound and comprehensive knowledge in the use of the instrument, and because he is also aware that failure to prepare material correctly can only yield poor results. He has covered a very wide field to this end and, in addition, has provided much specialised information on technique which can be applied to particular problems.

Following an historical introduction written by W. E. Watson-Barker, the author devotes two chapters to optical principles before he embarks on a detailed explanation of the instrument covering the eye-piece, the objective, the sub-stage condenser, illumination, the stand and mechanical parts. He then passes on to the use of the instrument and an introduction to the polarising microscope followed by chapters on micrometry and photo-micrography. The final chapter is devoted to the preparation of specimens. The book is very well illustrated throughout and contains a comprehensive index.

H. E. C.

THE STORY OF WOOL. By William F. Leggett. Pp. vi + 304, $7\frac{1}{2} \times 5$. (Brooklyn, New York: The Chemical Publishing Co., Inc., 1947.) Price \$5.

This book is easy to read and presents the history of wool in a manner which is at once interesting and enjoyable. The reader will not find a description of sheep raising nor of technical matters

concerning the preparation and marketing of this commodity, for the story unfolded is that of the employment of wool by man from earliest times to the present day. To this end the author takes you through the various ages from the origin of sheep, through medieval times and the Cloth Guilds to the present position of the wool industry in the various countries of the world. The opportunity to learn something about the habits and culture of ancient and medieval craftsmen provides a view of the past which should prove stimulating to those engaged or interested in the highly mechanised textile industry of to-day, and the position which the wool trade has occupied in social and political history of the different peoples of the world is a subject which cannot fail to hold the interest of a wider circle of readers. In addition to the various wools, the associated materials such as mohair, llama, vicuna, alpaca and other fibres are also dealt with. J. R. F.

Chemical Composition of Plants as an Index of their Nutritional Status. By D. W. Goodall, Ph.D., D.I.C., F.L.S., and F. G. Gregory, D.Sc., F.R.S. Technical Communication No. 17 of the Imperial Bureau of Horticulture and Plantation Crops. Pp. 167, $9\frac{3}{4} \times 7\frac{1}{2}$. (Imperial Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, 1947.) Price 9s.

At one time farming was carried out entirely on a basis of personal experience and possible slight knowledge, but to-day, with the progressive state of scientific knowledge, even farming can be scientifically planned. A knowledge of the soil being farmed and the nature and amounts of nutritive elements required by each crop would end half the farmer's worries.

This memoir, written by two leading exponents of the most modern branch of applied plant physiology, i.e. crop physiology, should prove of great use to all workers in the field of plant nutrition, who aim to aid farmers. Various queries will arise in the minds of such workers and they should obtain much help from this comprehensive survey in which much work of past workers is critically discussed. Among the very important subjects dealt with are included the relative merits of field trials and pot-cultures ; chemical *versus* biological methods of soil analysis ; methods of expressing results and the numerous factors affecting the use of plants for deficiency diagnosis.

There is a very useful bibliography of over 900 items in addition to author and subject indexes. R. W. P.

Spectrochemical Abstracts, Vol. III, 1940-1945. By Ernest H. S. van Someren, B.Sc., A.Inst.P. Pp. 112, $9\frac{3}{4} \times 6$. (London : Adam Hilger, Ltd., 1947.)

This volume constitutes an index to spectrochemical data which have been made available during the period 1940-1945. The book

is divided into two parts. Part I consists of a list of authors together with references to the literature they have published. In addition, there are also indexes to elements observed as minor constituents of non-metallic substances and of metals. Part II is a subject index covering biological materials, ceramics and slags, gases and liquids, minerals and ores, non-metallic solids and metals. Each entry has a short review of the literature referred to. References to apparatus, methods, source theory, summaries, reviews and books are also given in this section. The two parts of the book are cross-referenced with numerals which run consecutively, with the earlier volumes.

This book will prove of great value to those who require quick reference to original papers on spectrochemical investigations.

H. E. C.

WOOD PULP AND ALLIED PRODUCTS. By Julius Grant, M.Sc., Ph.D. (London), F.R.I.C. Second Edition. Pp. xvi + 312, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Leonard Hill, Ltd., 1947.) Price 35s.

This work was first published under the title of *Wood Pulp* in 1938, as the second volume of a new series of plant science books. New applications have so increased the importance of cellulose that it has been necessary to widen the scope of this book, and the title has therefore been expanded to *Wood Pulp and Allied Products*. In its second edition the author has retained the original format of its predecessor but has considerably revised and added to the text with special reference to the use of cellulose in the manufacture of rayon and plastics.

The text follows the natural sequence of events from the pulp wood to the wood pulp and includes chapters on the nature of cellulose and wood fibre; the identification and evaluation of pulping wood; the preparation of the wood for pulping; the mechanical, sulphite and alkaline processes for pulping the wood; the bleaching of the pulp; chemical and physical methods of testing the pulp and finally the commercial uses of the pulp.

Grant's *Wood Pulp* has come to be regarded as a standard work on this subject and the revised edition will be welcomed by all those who have made use of the first edition. If an improvement may be suggested, it is that additional photographs of apparatus and plant might add to its usefulness. Written in a clear and concise style and furnished with a useful bibliography and a good index, the new edition will be valuable both as a text-book and as a book of reference.

H. E. C.

ANNUAL REVIEW OF MICROBIOLOGY. Vol. I, 1947. Edited by Charles E. Clifton. Pp. vii + 404, $8\frac{3}{4} \times 6$. (California: Annual Reviews, Inc., Stanford University P.O., 1947.) Price $6.00.

The rapid advance which is taking place in the microbiological field has resulted in such a large increase in the literature on the

subject that it is impossible to keep in touch with all the latest developments. In order to condense this vast store of information it has been decided to publish each year summaries of the work carried out in the more active fields of research in the form of an *Annual Review of Microbiology*. It is hoped in this way to satisfy the needs of microbiologists with diverse interests and supplement the information given in the current journals.

The first volume published in 1947 covers a wide field and includes chapters on the morphology and cytology of protozoa; the life-cycle of malarial parasties; the variation in phytopathogenic fungi; bacterial metabolism; nitrogen metabolism; industrial fermentation; the quaternary ammonium compounds; antibiotics; chemotherapeutic agents; immunochemistry and the respiratory viruses.

Each subject is critically reviewed by an author who is familiar with his particular subject, and the volume is edited by C. E. Clifton of Stanford University, U.S.A. A valuable feature of the book is the numerous references to original papers, a list of which is appended as a bibliography at the end of each chapter. This book should prove a useful annual addition to the library of those interested in microbiology.

H. E. C.

DECAY OF TIMBER AND ITS PREVENTION. By K. St. G. Cartwright, M.A., and W. P. F. Findlay, D.Sc. Pp. vi + 294, $9\frac{3}{4} \times 6$. (London: His Majesty's Stationery Office, 1946.) Price 12*s*. 6*d*.

The authors have covered a wide field in this excellently arranged and well illustrated book which brings together all available information on the rots of timber and correlates it with the results of recent research in this country and abroad.

The principal decays of standing trees in this country, both conifers and broad-leaved trees, their causes and recognition are fully described and in the same way the rots of felled timber, of timber in service in the open, in buildings and structures, in mining and ships and boats are dealt with. The tables of diagnosis of fungi are very useful. There are chapters on the prevention of decay in felled and converted timber during storage and shipment and on the preservative treatment of wood with chemicals. The final chapter discusses staining and discolouration in timber and their causes and prevention. Mention should be made of the extensive bibliographies which conclude each chapter throughout.

There is no doubt that this is an excellent reference book and will be invaluable to those concerned with forestry, to students, and to the timber industry.

R. M. J.

THE CHEMICAL CONSTITUTION OF NATURAL FATS. By T. P. Hilditch, D.Sc. (Lond.), F.R.S., F.R.I.C. Second Edition. Pp. xiii + 554, 10 × 6¼. (London: Chapman & Hall, Ltd., 1947.) Price 45s.

The publication of the second edition of this standard work by Professor Hilditch on the chemical constitution of natural fats is most welcome. Since the appearance of the first edition in 1940 (reviewed in this BULLETIN, 1940, **38**, 353) a considerable amount of fresh knowledge has been acquired, and on this account the number of pages has been increased by about a hundred. The presentation of the data regarding the chemical constitution of the fats as originally made in the first edition has been maintained, namely their classification has been made on a biological basis, rather than according to their technical applications or their physiological functions.

The main additions to this second edition are the inclusion of data relating to the component acids of a number of seed fats and depot fats from a wider range of animals, including the human species. The development of methods of investigating more adequately the more liquid and unsaturated acids is described together with the results of other work on the component glycerides, whereby more light has been thrown upon their formation in animal depot and milk fats and whereby greater understanding is given of the empirical methods for predicting glyceride composition from that of the component acids. Recently published information on certain individual fatty acids is incorporated in this new edition. The final chapter on experimental technique employed in the quantitative investigation of fats has been revised, especially that part dealing with the methods of interpretation of ester-fractions involved in the determination of component acids.

This book occupies a unique place in the literature on oils and fats and will continue to be of inestimable value to all those who are concerned with these products.

G. T. B.

THE COLONIES TODAY AND TOMORROW. By Sir Drummond Shiels, M.C., M.B. (British Commonwealth Affairs, No. 1). Pp. 36, 8½ × 5½. (London, New York, Toronto: Longmans Green & Co., 1947.) Price 1s.

This is the first of a series of pamphlets to be published under the auspices of the Royal Empire Society " to provide a forum for the discussion of current questions relating to the British Commonwealth and Empire." The Society is to be congratulated on this new series—aptly entitled " British Commonwealth Affairs " ; on their choice of subject for the first issue ; and on their selection of Sir Drummond Shiels as author. Sir Drummond has for many years past studied the Colonial Empire, both on the spot and from

published documents, and his word will carry weight not only in this country, but also in the overseas territories, which are his theme and in many of which his name is a household word.

A thoughtful perusal of this pamphlet certainly does provide points for discussion. For example, on page 7, the classification of Colonial Dependencies should surely have included some reference to "Protected States." It is interesting to remember how great was the importance attached to the idea of "Protection" by British Empire-builders during the second half of the nineteenth century—indeed, ever since the measures taken to stamp out slavery, from 1833 to the turn of the new century. Indirect Rule is most successful where both rulers and subjects are naturally democratically minded, and as a matter of course the spirit of democracy will throw out different forms of administration to suit differences of intellectual, economic and social advancement.

Economic and social problems of the Dependencies are admirably dealt with on pages 9-26. It can never be too clearly emphasised how important is the change of heart underlying the Colonial Development Act of 1929 and still more obviously the addition of the word "Welfare" to the similar Acts of 1940 and 1945; for if Colonies are left to make their own way in social welfare on the basis of their own material resources alone, then the devil will indeed take the hindermost. The Acts just cited do help to break the vicious spiral.

Constitutional Problems (pp. 26-32) and "Some Questions and Conclusions" (pp. 32-33) raise interesting points in this all-too-short pamphlet. Constitutional progress towards more and more advanced forms of local self-government is certainly marked and the instances quoted are striking. One last gauntlet must be thrown down, in the hope that one day Sir Drummond Shiels may be moved to pick it up and give us his views. On page 7 he writes: "The only formal link between them (the Dominions) is the Crown, though, as two wars have shown, Great Britain and the Dominions have bonds of sentiment and of common democratic objectives more powerful than formal ties." But surely these are our native traditions. They are our birthright; and the Crown, which is also our birthright, is accepted by all to whom these traditions are dear, for it unites, represents and makes real all that is best in our great democratic inheritance.

H. A. F. L.

THE FREEZING PRESERVATION OF FOODS. By Donald K. Tressler, Ph.D., and Clifford F. Evers, B.S. Second Edition. Pp. xviii + 932, 8 × 5¾. (New York: The Avi Publishing Co., Inc., 1947.) Price $10.00.

Freezing has been used as a method of preserving food for many years, and as long ago as 1865 artificial freezing of fish on a commercial scale began in the United States. As time advanced this

process of preservation was applied to food other than fish and the mechanical refrigeration of food came into vogue. In 1925 the quick freezing method began to be adopted in the frozen fish industry—a method which of more recent years has been used more extensively so that not only fish but other foods are preserved by this more modern process. To-day not only fish and meat, but also vegetables, fruits and dairy and farm produce are preserved by some form of refrigeration.

The use of freezing methods has assumed such importance during the last few years that considerable attention has been given to this subject in the technical press. In 1943 the authors (see this BULLETIN, 1943, **41**, 190) enlarged the scope of their first general treatise entitled *The Freezing Preservation of Fruits, Fruit Juices and Vegetables*, published about five years earlier, so as to include meat, poultry, fish and dairy produce and changed the title to that of the volume now under review. Since 1943, however, the technology of food freezing has advanced so rapidly that the authors were compelled to rewrite their book in order to bring its contents up to date. This the authors have done in their second edition.

The great importance of freezing as a commercial method of the preservation of food has necessitated the introduction of an entirely new section on the economic status of this industry. Besides indicating the present prominent position of refrigeration the authors have given statistics to give an idea of production and factory costs. Home freezing and the use of home freezers has become so general, especially in the United States, that further information has been added on this subject and an entirely new section has been devoted to methods that can be recommended for use in the home for preparing all kinds of food for freezing. Originally refrigeration was mainly applied to uncooked food, but owing to the extension of this method to cooked foods and baked goods a relevant chapter has been included. In view of our present advanced knowledge of the necessity for strict hygiene in the preparation of food the inclusion of a new section devoted to the microbiology of frozen foods and plant sanitation is particularly apposite.

This book is clearly printed and well arranged and has over 200 illustrations. Its contents are very comprehensive and the book is packed with information which cannot but be of great value to all those interested in the preservation of food by freezing.

G. T. B.

ANIMAL NUTRITION. By Leonard A. Maynard, A.B., Ph.D., Sc.D. Second Edition. Pp. xviii + 494, $9\frac{1}{4} \times 6$. (New York and London: McGraw-Hill Book Co., Inc., 1947.) Price $5.00.

In view of the present-day shortage of feeding stuffs and the great need to increase the number of cattle, sheep and pigs for human consumption, great importance must be attached to the proper feeding of animals so as to produce the maximum increase

and to the selection of those feeding stuffs which are the most economical.

Since the end of the eighteenth century, when Lavoisier carried out his experiments showing that chemistry was of great importance in nutrition studies, this subject has been very thoroughly investigated, although even to-day one's knowledge of the underlying principles is far from complete. The author, conscious of a need for a text-book on animal nutrition, undertook this task and in 1937 brought out the first edition of his work. Since that date, however, many important advances have been made in this study and it has been found necessary to issue a second edition of this standard work.

Perhaps the chief advance made during this period lies within the sphere of vitamins. These important constituents of food have had considerable attention paid to their functions, especially as a result of war conditions. Many hitherto unexplained complaints of animals have now been shown to be due to the lack of the necessary vitamins. The author in the chapter devoted to this subject deals with the important members of this group, giving information regarding their sources and describing the effect they have on the growth and freedom from disease of animals. Other subjects of which one's knowledge has been largely developed of recent years concern protein and mineral nutrition and the nutritional rôles of carbohydrates and fats.

With a view to maintaining the size of the book close to that of the original, less important material has been omitted from this second edition to make room for the necessary additions. After the opening chapters on the expanding field of nutrition, the animal body and its food, and some physiochemical bases of life processes, four chapters are devoted to the metabolism of the carbohydrates, lipids, proteins and inorganic elements. Others deal with feeding experiments, nutritional balances, maintenance, growth, reproduction and lactation. At the end of the chapters are given lists of selected literature, which should be consulted by all those who desire to study the original works mentioned in the text.

The book is well printed and the illustrations are clear. Author and subject indexes complete the volume. This text-book is of high standard and will be of great value, not only for students for whom it is particularly intended, but to others who wish to deal with the feeding of animals on modern scientific lines.

G. T. B.

BOOKS RECEIVED FOR REVIEW

NATURAL PERFUME MATERIALS. By Dr. Y. R. Naves and G. Mazuyer. Translated from the First French Edition by Edward Sagarin. Pp. xvii + 338, 9 × 6. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) Price 40*s*. 6*d*.

THE DEHYDRATION OF FOOD. By T. N. Morris, M.A. Pp. vii + 174, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman and Hall, Ltd., 1947.) Price 15*s*.

REPORT OF THE NEW FOREST COMMITTEE, 1947. Cmd. 7245. Pp. 104, $9\frac{3}{4} \times 6$. (London: His Majesty's Stationery Office, 1947.) Price 3*s*. 6*d*.

THE WATER-SOLUBLE GUMS. By C. L. Mantell, Ph.D. Pp. v + 279, 9×6. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) Price 36*s*.

FARMING AND MECHANISED AGRICULTURE, 1948. Advisory Editor: Sir R. George Stapledon, C.B.E., M.A., F.R.S. Pp. 403, $8\frac{3}{4} \times 5\frac{1}{2}$. (London and New York: Todd Reference Books, Ltd.) Price 25*s*.

BUNA RUBBER: THE BIRTH OF AN INDUSTRY. By Frank A. Howard. Pp. xii + 307, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1947.) Price 21*s*.

THE SOUTH AND EAST AFRICAN YEAR BOOK AND GUIDE. Edited annually by A. Gordon-Brown, F.R.G.S., for the Union-Castle Mail Steamship Company, Ltd., 1948 Edition. $7\frac{1}{4} \times 4\frac{3}{4}$. (London: Sampson Low, Marston and Co., Ltd.) Price 7*s*. 6*d*.

COLONIAL AGRICULTURAL PRODUCTION. By Sir Alan Pim. Pp. ix + 190, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: New York: Toronto: Oxford University Press, 1946.) Price 10*s*. 6*d*.

HORMONES AND HORTICULTURE. By George S. Avery, Jr., and Elizabeth Bindloss Johnson. Pp. xi + 326, 9×6. (New York and London: McGraw-Hill Book Company, Inc., 1947.) Price 27*s*.

THE SKYSCRAPER HIVE. By Father M. Dugat. Pp. xvi + 78, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: Faber and Faber, 1948.) Price 8*s*. 6*d*.

FERGUSON'S CEYLON DIRECTORY FOR 1947. Compiled and Edited by the Staff of the *Ceylon Observer*. Pp. vii + 1,519, $8\frac{3}{4} \times 5\frac{1}{2}$. (Colombo: The Ceylon Observer Press.)

MILK PRODUCTS. By Wm. Clunie Harvey, M.D., D.P.H., F.R.San.I., and Harry Hill, F.R.San.I., A.M.I.S.E., F.S.I.A. Second Edition. Pp. viii + 343, $10 \times 6\frac{1}{4}$. (London: H. K. Lewis and Co., Ltd., 1948.). Price 30*s*.

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Compiled by Miss R. M. Johnson

Comprising the more important reports, articles. etc., contained in publications received in the Library of the Imperial Institute during the three months May-July, 1947.

The publications issued by the Governments of the Colonies and Protectorates can be obtained from or through the Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1. Applications for the Dominion Governments publications may be made to the Offices of the High Commissioners or Agents-General in London.

Publications of the U.S. Departments of Agriculture and of Commerce are obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

AGRICULTURE

General

Reports of the Agricultural Enquiry Committee, Government of Northern Ireland. Pp. 312. (Belfast: H.M. Stationery Office, 1947.) Price 3*s.* 6*d.* The Committee was appointed to enquire into and report upon the future of agriculture in Northern Ireland and to advise upon the steps necessary to effect its maximum development and improvement.

Annual Report of the Department of Agriculture, Basutoland, for the year ended September 30, 1946. Pp. 28. (Maseru: Agricultural Department, 1947.)

Report of the Director of Agriculture, Bermuda, for 1946. Pp. 14. (Bermuda: Government Printer, 1947.)

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Report of the Department of Agriculture, Nyasaland, for 1945. Part I. Pp. 18. (Zomba: Government Printer, 1947.) Price 2*s.* 6*d.*

Report of the Department of Agriculture, Nyasaland, for 1945. Part II. Experimental Work. Pp. 13. (Zomba: Government Printer, 1947.)

Annual Report on the Agricultural Department, St. Vincent, for 1945. Pp. 20. (Kingstown: Government Printing Office, 1947.)

Annual Report of the Department of Agriculture, Sierra Leone, for 1945. Pp. 24. (Freetown: Government Printer, 1947.) Price 1*s.* 6*d.*

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Sixty-fifth Annual Report of the New York State Agricultural Experiment Station, Geneva, New York, 1946. Pp. 73. (Geneva, N.Y.: Agricultural Experiment Station, 1947.)

Panorama of Agricultural Research, Texas. Fifty-eighth Annual Report of the Texas Agricultural Experiment Station for 1945. Pp. 76. (Texas: Agricultural Experiment Station, 1946.)

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The Quality of Mature *Pinus patula* and *P. insignis* Timber Grown in South Africa. By M. H. Scott and R. P. Stephens. Paper prepared for the Fifth British Empire Forestry Conference, London, 1947. Pp. 23. (Pretoria: Department of Agriculture and Forestry, 1947.)

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Onderzoek naar de Duurzaamheid tegen Paalworm van Eenige Tropische Houtsoorten. By W. Spoon and F. E. Loosjes. *Ber. No.* 210, *HandMus. Indisch Inst.* Pp. 8 (Amsterdam: Indisch Instituut, 1947.) The resistance of some tropical timbers against teredo.

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Modern Turpentining Practices. By W. P. Everard. *Frms'. Bull. No.* 1984, *U.S. Dep. Agric.*, 1947, pp. 12.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY OF INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 39

(April to June 1947)

Compiled by Miss R. M. Johnson

With the collaboration of the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

Observations on Mortality among Insects exposed to Dry Insecticidal Films. By J. R. Busvine. *Bull. Ent. Res.*, 1947, **38**, Pt. 1, 81-90. The insecticides used in the tests were DDT, gammexane, pyrethrum and rotenone.

Experiments with Insecticides on Honeybees. By P. W. Eide. *J. Econ. Ent.*, 1947, **40**, No. 1, 49-54. The tests included the use of pyrethrum, rotenone and sabadilla: rotenone toxic under certain conditions, sabadilla highly toxic.

Particle Size of Insecticides and Its Relation to Application, Distribution and Deposit. By S. F. Potts. *J. Econ. Ent.*, 1946, **39**, No. 6, 716-720.

How to Control Fleas. By F. C. Bishopp. *Leafl. No.* 152, *U.S. Dep. Agric.*, 1946. Derris, cube, pyrethrum or DDT recommended.

Further Tests for Control of Mexican Bean Beetle and Corn Earworm on Snap Beans. By L. W. Brannon. *J. Econ. Ent.*, 1947, **40**, No. 1, 103-106. Pyrethrum and rotenone included in the tests.

Control of Grasshoppers Injuring Apple Orchards. By C. Graham and E. N. Cory. *J. Econ. Ent.*, 1946, **39**, No. 6, 816. Nicotine sulphate and pyrethrum both ineffective: a commercial spray containing DDT, rotenone and pyrethrum gave about 85 per cent. kill.

Combating Fruit Pests in Kansas. By G. A. Filinger. *Circ. No.* 235, *Kansas Agric. Exp. Sta.*, 1946. Discusses the uses of nicotine sulphate, pyrethrum and derris in the spraying schedule.

Cattle Lice: their Biology and Control. By J. G. Matthysse. *Bull. No.* 832, *N.Y.* (*Cornell*) *Agric. Exp. Sta.*, 1946. (*Amer. Chem. Absts.*, 1947, **41**, No. 6, 1800.) Dusting was the best method of controlling cattle lice: derris or cube controlled all species of lice: sabadilla could be substituted for rotenone; nicotine ineffective; pyrethrum was toxic but could not be relied upon; hellebore low in toxicity; preliminary tests with nicotine and lethane appeared to give control; DDT fairly effective but not so effective as rotenone or sabadilla in dusts.

Wartime Development of Insecticides. By H. L. Haller. *Industr. Engng. Chem., Industr. Ed.*, 1947, **39**, No. 4, 467-473. Discusses nicotine, rotenone and pyrethrins.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Control of French Bean Fly. Experiments with DDT. By P. C. Hely. *Agric. Gaz. N.S.W.*, 1947, **58**, Pt. 2, 85-89. Nicotine gives good control of the pest but DDT offers certain advantages.

Currant and Gooseberry Aphides. *Adv. Leafl. No.* 176, *Minist. Agric. Lond.*, 1947. Nicotine recommended for the control of these pests if winter washing has not been carried out.

As Brocas da Aboboreira. By J. Soares Brandão. *Bol. Minist. Agric. Brazil*, 1945, **33**, No. 6, 81-85. (*R.A.E.*, 1947, **35**, A, Pt. 4, 107.) Infestations of *Diaphania* spp. on squash and other cucurbits can be controlled by nicotine sprays.

Oil-Soluble Copper-Nicotine Compounds. U.S. Pat. No. 2,414,213. (*Amer. Chem. Absts.*, 1947, **41**, No. 8, 2530.) Compounds soluble in hydrocarbon oils but insoluble in water and useful as insecticides are made by the reaction of nicotine with the copper salts of various soap-forming acids.

The Leaf-Rolling Rose Sawfly, *Blennocampa pusilla* Klug. By G. Fox-Wilson. *J. Roy. Hort. Soc.*, 1947, **72**, Pt. 4, 155-158. Nicotine-soap wash recommended; nicotine dust partially effective against the larvae within the rolled leaflets.

Pest Control in Commercial Fruit Plantings. By D. Powell, S. C. Chandler and J. V. W. Kelly. *Circ.* 610, *Univ. Illin. Coll. Agric.*, 1947. Gives a series of spray schedules to cover many fruit diseases and pests; nicotine, DDT, lead arsenate and other preparations included.

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MINERAL RESOURCES

ARTICLE

THE GEOLOGY AND MINERAL RESOURCES OF KENYA[1]

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THE first records of the geology and mineral resources of the Colony and Protectorate of Kenya were accumulated towards the end of the nineteenth century. Early in the present century official geologists were appointed for short periods, and in addition, temporary Colonial Office appointments were made for specific investigations, as in 1914-15 for the examination of a portion of the Northern Frontier District. A permanent Geological Survey, incorporated in the Mines Department, was organised in 1932, and has continued to function, though normally with limited staff. More progress was made between 1940 and 1943 with the aid of a grant from the Colonial Development Fund. At the beginning of 1946 the Geological Survey became a section of a combined Lands, Mines and Surveys Department. Throughout the period of official survey, assistance on various problems has been given by the Imperial Institute.

PHYSICAL FEATURES

The Colony and Protectorate is about 225,000 sq. miles in extent, or roughly twice the area of the British Isles. Broadly, its physiographical features are as follows:

I. A narrow coastal plain in the south-east, broadening into a wide embayment north of the River Sabaki.

II. Behind the plain in the south-east lies a narrow shelf averaging about 200 ft. above sea-level, underlain principally by Jurassic shales.

III. A discontinuous chain of hills, made up of Mesozoic sediments, rises to about 1,000 ft. or more (Mangea, 1,702 ft.; north Kwale, 1,476 ft.) west of the coastal shelf.

IV. The Nyika, an extensive peneplain (the sub-Miocene peneplain in part) with scattered hills, ranges and lava plateaux, increasing westwards in altitude from about 800 to 4,000-5,000 ft., lies west of the coastal hills. Its eastern portion is made up of Palaeozoic and Mesozoic sediments, the larger western part of

[1] Lecture delivered on February 27, 1947, at the Imperial Institute.

Archaean rocks or recent volcanics. The Yatta Plateau, a narrow, irregular-margined lava-capped tableland, stretches from the lower part of the Highlands north of Nairobi, to the region of Tsavo, a distance approaching 150 miles.

V. The western edge of the Nyika is bounded by extensive hill areas, composed of Basement System rocks. The summit levels of the hills mark the remnants of an early peneplain, possibly of late Jurassic age.

VI. West of the hills there is a broad belt, stretching from the region of Lake Magadi to Lake Rudolf, of Tertiary to Recent volcanic rocks which in the south form the Kenya Highlands. The highest points are Mt. Kenya (17,007 ft.) and the flanks of the Rift Valley west of Mt. Kenya (Sattima and Niandarawa in the Aberdare Mountains, 13,214 and 12,816 ft. respectively; the Elgeyo Escarpment, 8,000 to 9,000 ft.; Mau, 9,848 ft.). The western portion includes the Uasin Gishu Plateau (a widespread upland plain, of general altitude about 6,000 to 7,500 ft. above sea-level) and the Kericho Highlands (6,000 to 7,500 ft.).

VII. Roughly in the middle of the volcanic belt lies the Kenya Rift Valley, a more or less meridional depression about 30 to 40 miles in width in its narrower portions, but up to 80 miles where it widens, and with its floor often lying several thousands of feet below the level of the country on either side. Drainage is internal and several fresh and saline lakes lie within the Rift. Magadi (Plate II) is a soda lake, constituted mainly of solid trona.

VIII. The country west of the highlands consists mainly of a peneplain (4,000 to about 5,500 ft.) underlain by pre-Cambrian rocks invaded by granites and other intrusions. On the south-east there are plateau highlands (about 7,000 ft.) made up of the Kisii Series of sediments and lavas. Isolated areas within the western belt are mountainous and are centres of Tertiary volcanic activity. The principal areas are Mt. Elgon (14,140 ft.) and the Gwasi (Gembe, 6,237 ft.)–Ruri-Homa Mountain (5,741 ft.) group.

IX. The westernmost part of Kenya is a portion of Lake Victoria (3,726 ft.), with a few off-shore islands. The Kavirondo Gulf is a shallow sound extending inland for about 45 miles and which formerly extended much further to the east. Both on the north and south of the Gulf there are escarpments, believed to be due to faults.

X. The Northern Frontier District (N.F.D.)[1] forms a considerable portion of the Colony, and consists principally of a peneplain of ancient schists and gneisses, and sediments of Jurassic to Miocene age together with recent lava plains and volcanoes. There are scattered residual hills and mountains of the older rocks, and in places large volcanic piles are noteworthy, e.g. Marsabit (5,561 ft.) and Kulal (7,912 ft.).

[1] The Northern Frontier District and Turkana District were united to form the Northern Province in April 1947.

Geology

The principal groups of rocks found in Kenya are summarised in the following table, and their general distribution is shown in the accompanying geological sketch map (*facing p.* 279).

Geological Succession

Age	*Representatives*
Recent . .	Soils, alluvials, Magadi trona lake, hot spring deposits.
Pleistocene . .	Raised coral reefs and sandstones at the coast. Rift Valley sediments. Some volcanic rocks of the Highlands.
Tertiary . .	Coastal sediments. Volcanic rocks of the Highlands, Western Kenya and the N.F.D. Inland Miocene. Instrusives of Tertiary age.
Mesozoic . .	Sediments at the coast and in the N.F.D.
Palaeozoic(?) . .	Sediments and volcanics of the Kisii Series (Bukoban) of Western Kenya.
Pre-Cambrian . .	Sediments and volcanics of Western Kenya, with large granite intrusions. Occasional basic intrusives elsewhere. Dunites cutting the Basement System.
Archaean . .	Gneisses and schists, etc., of the Basement System.

Basement System

The crystalline rocks of the Basement System cover wide areas of the Colony, and are particularly extensive in the eastern half. They comprise principally various types of sediments—grits, sandstones and shales—that have been metamorphosed into gneisses and schists by heat and pressure or by impregnation by magmatic fluids. Igneous rocks are relatively scarce and consist of granite sheets and dykes, and sills of epidiorite and amphibolite derived from originally doleritic or allied rocks. Some are apparently of later date than the metamorphism of the sedimentary hosts, but are probably pre-Cambrian in age.

The variety of rocks in the sedimentary series is extensive and includes, besides the widespread mica- and mica-hornblende -schists and -gneisses, such types as graphite-schists, kyanite-gneisses, garnet -gneisses and -schists, sillimanite-gneisses, pyroxene-granulites, quartzites and crystalline limestones. Other and rarer kinds include actinolite-schists, anthophyllite-schists, and epidote -schists and -gneisses. In most areas there are considerable developments of migmatites, which are frequently markedly banded.

The crystalline limestones form notable bands and lenses, often of considerable thickness and length, though some are small. A series of outcrops extends discontinuously through the central part of the Colony from the region of Voi to the Northern Frontier District, and others occur in the hills east of Mt. Elgon. The graphitic gneisses also in places form thick and extensive bands.

Intrusions into the Basement System

No major invasions of the Basement System by rocks of granitic type have been located. Extensive outcrops of basic rocks, including pyroxenites, norites and anorthosites have, however, been found piercing it east of Mt. Kenya. It is possible that mineral deposits

such as are commonly associated with plutonic rocks of that type —nickel, copper, chrome and titaniferous magnetite are examples— may be found in these or similar rocks within that area of the Colony.

Dunites are represented by pipes at a few localities, e.g. near Mtito-Andei, and in the Kitui and Northern Frontier Districts. All are associated with deposits of magnesite, and at Mtito-Andei, numerous other minerals have been found and worked to some extent.

Pre-Cambrian

The pre-Cambrian rocks of the Colony are essentially those of the goldfields of Western Kenya. They are to a considerable extent blanketed by younger rocks, notably in the Kisii and Gembe areas of Southern Kavirondo. Two systems have been distinguished, the older called the Nyanzian, and the younger the Kavirondian System.

The *Nyanzian System* in North and Central Kavirondo is made up of a great thickness of lava flows, associated with variable thicknesses of pyroclastic rocks of all grades, and in places with lenses of conglomerates. In Southern Kavirondo the System includes other sediments, among them normal clastic types, and banded ironstones, especially in the Migori Gold Belt. Rocks of the System, in a highly altered state, also outcrop east of the Kisii Highlands.

The *Kavirondian System* is most typically developed in Northern and Central Kavirondo, where its alternating bands of grit or sandstone and mudstones cover wide stretches of country. Intercalated among the finer-grained sediments are huge lenses of water-lain conglomerates that have proved auriferous in a few localities. In Southern Kavirondo the System is mainly represented by extensive developments of boulder conglomerates. Finer-grained sediments are, however, also present, and in the Migori Gold Belt lavas form part of the System.

Intrusions into the pre-Cambrian rocks

The pre-Cambrian rocks are extensively invaded by granites. In the northern part of Nyanza Province the main granites are post-Kavirondian and genetically connected with the gold deposits. In Southern Kavirondo the principal intrusion is, however, of post-Nyanzian—pre-Kavirondian age, and is apparently that associated with gold mineralisation in the Migori Gold Belt. In this area there are also extensive intrusions of diorite-porphyrite of post-Kavirondian age which appear to be unconnected with any valuable mineralisation.

In addition to the major igneous rocks, the pre-Cambrian of Western Kenya is invaded by innumerable small masses and dykes of many kinds of rocks ranging from acid to basic in character.

Palaeozoic

Bukoban System (Kisii Series)

The Kisii Series is restricted to a small area in the south-western part of the Colony, where it gives rise to the Kisii Highlands. The Series is threefold with upper and lower divisions of lavas, and a middle division composed largely of quartzites. The quartzites in places form prominent escarpments at the edges of the plateau. Frequently on the western side of the highlands there are lenticle-like masses of soapstone which are metasomatic replacements of the lower lavas.

On its eastern side the Series has an impersistent basal conglomerate, in which gold has been found. Traces of cassiterite are found in heavy residues from the quartzites.

The Series lies more or less flatly, with only gentle folding, across the upturned edges of the goldfields formations, and is in fact a thick and impenetrable blanket covering many square miles of what might otherwise have been potential goldfield. There is no evidence of the precise age. It has frequently been considered as possibly Palaeozoic, but it may be pre-Cambrian, though considerably younger than the goldfields formations.

Coastal Palaeozoic Sediments

The western portion of the Coastal sediments south of the Tana River consists of a monotonous series of shales, grits, and sandstones with thin coals, that from fossil evidence has been dated as Permian. There is a passage into sediments of Mesozoic age.

Mesozoic

Coastal Mesozoic Sediments

A continuous strip of sediments of Mesozoic age about 20 miles in width is exposed near the Coast, stretching from the Tanganyika border to the region of the River Tana. The sediments range in age from Triassic to possibly Cretaceous, and include portions of the Jurassic System. The oldest and westernmost sediments are largely sandstones with apparently subordinate shales. Certain beds are prolific in fossil tree remains. The Trias sequence ends with a series of grits, often pebbly, that cap the coastal hill ranges.

The lowest beds of the Jurassic are marine limestones, in part remarkably pure, which in places have wide and easily worked outcrops. They are overlain by a thick series of beds, predominantly shales, but with some grit horizons, and frequently with bullion bands.

Only in one place have supposedly Cretaceous limestones been found, and the occurrence perhaps requires verification.

Intrusions in the Coastal Sediments

The only intrusions known in the coastal belt are at Jombo, not far from the Tanganyika border, and small masses in the Sabaki

valley at the north end of the belt. The Jombo intrusions include ijolites, nepheline-syenites, and jacupirangites, and dykes of camptonitic type. They are post-Trias, and on comparison with similar rocks recently discovered in Western Kenya may perhaps be referred to the Tertiary. It is likely that ouachitites discovered some years ago piercing Basement System rocks in Eastern Kitui are of similar age, and consanguineous with the coastal intrusions.

Mesozoic Sediments of the Northern Frontier District

The north-eastern corner of the Colony, over an area of several thousand square miles, is occupied by Mesozoic sediments, which cannot be directly correlated with those of the coastal belt. They are principally Jurassic limestones and sandstones, with shales, clays and gypsum beds. The Marehan sandstones overlying the marine Jurassic limestones have been identified as of Cretaceous age by some authors and as up-faulted Trias by others, but more recent investigation suggests that they are the uppermost part of the Jurassic sequence.

Tertiary

Coastal Sediments of Tertiary Age

Small exposures of fossiliferous sediments, referred to early or middle Tertiary times, have been found in the Coastal area, but the principal Tertiary sediments are a series of red sands and sandstones that lie a short distance inland and frequently form a chain of low hills. The sediments rest on a planed surface of Jurassic rocks, and have been ascribed to Pliocene times.

Tertiary Rocks of the Interior

Miocene sediments have been found at numerous inland localities resting on the sub-Miocene peneplain or in gullies cut into it. Deposits occur close to the shores of Lake Victoria, around Koru and Muhoroni and around Mt. Elgon. Other occurrences have been found in the Rudolf basin, and at several places in the wide area east of that lake and north of Mt. Kenya. Finally, extensive lake deposits are found intercalated among lavas near Nairobi; they contain beds of bentonitic clay and are a useful aquifer.

The sediments are mainly shallow water lacustrine deposits, and in some cases estuarine. Thin limestone beds are not infrequent and usually yield representative faunas.

In addition to the water-lain sediments of Tertiary age there are widespread occurrences of lavas and pyroclastic sediments of Middle or Upper Tertiary age in Central, Northern and Western Kenya. Many of the lavas are of alkaline type, including, for example, phonolites, nephelinites and alkaline rhyolites and basalts, though calc-alkaline types are by no means absent and in places predominate. Some of the lavas have given rise to extensive plains or plateaux. Others, with accompanying ash and agglomerate beds, are the result of the action of central volcanoes. More

obvious central volcanoes are represented by Mt. Kenya, the Aberdares, Mt. Elgon, and some of the volcanic masses of the western part of Southern Kavirondo.

Intrusions of Tertiary Age

Few intrusive rocks of Tertiary age are known. The coast intrusives, mentioned previously, may be of Tertiary age, and alkaline intrusions and carbonatites found on Homa Mountain and nearby in Southern Kavirondo belong to this period. The core of Mt. Kenya is an alkaline syenite and there is an essexitic mass on the south-western flank of the Aberdares.

Pleistocene

Rocks of Pleistocene age are represented at the coast by raised coral reefs and sandstones. Inland, Pleistocene sediments are more extensively developed, particularly in the Rift Valley, where they are represented by thick deposits of lacustrine and fluviatile sediments among which diatomite beds are commonly found intercalated. Considerable progress has been made in the division and dating of such deposits by means of artefacts and vertebrate remains, and a sequence of pluvial and interpluvial periods, corresponding with the waxing and waning of the glaciations in Europe, has been made out. The sequence shows alternations of wet and " dry " periods, with a gradual but constant diminution of the intensity of wet periods since early Pleistocene times.

Pleistocene beds have been found at localities outside the Rift Valley, for example, in the Kitui district where Pleistocene pond or fluviatile sediments are associated with irregular gypsum deposits.

Pleistocene deposits of a more European type are found on the higher mountains where moraines, solifluxion deposits, and other glacial phenomena are seen.

Volcanic rocks of Pleistocene or presumed Pleistocene age are found in several parts of the Highlands, in Nyanza Province, and in the Northern Frontier District. The volcanic cones from which the lavas and tuffs were ejected are often excellently preserved.

Recent Deposits

The deposits of Recent age are largely soils and alluvial accumulations. The desiccation of lakes has led to the accumulation of salts, particularly at Lake Magadi, which is a lake of solid trona with interstitial mother liquor, fed and maintained by saline springs. Mineral springs and fumaroles are known in various parts of the country, but do not so far as is known give rise to extensive mineral deposits. The principal localities lie within the Rift Valley, though hot springs are also found near the coast and in western Nyanza Province.

There is no modern vulcanicity, though it is within the memory of man that Teleki's Volcano, near the southern end of Lake Rudolf, erupted.

Tectonic Events

Throughout much of its history East Africa has been unaffected by major tectonic disturbances, though at early and again at late periods extensive movements took place. Insufficient work has been carried out to determine the full sequence of events in Archaean times. Towards the end of the pre-Cambrian period mountain building movements are indicated in Western Kenya by the upturned remains of the Nyanzian and Kavirondian Systems. Since then and until late Tertiary times movement appears to have been confined mainly to general uplift of the whole of East Africa, followed by long continued denudation that led to peneplanation of much of Kenya by late Jurassic times. General uplift followed, again with subsequent denudation over the remainder of the Mesozoic and the early part of the Tertiary era, leading to the formation of the sub-Miocene peneplain. Since the Miocene, movement has been mainly confined to geologically moderate vertical or tilting movements of which the effects are most readily seen along the Rift Valley, at the coast, and in Western Kenya.

Rift Valley

The Gregory Rift Valley cuts completely across Kenya from the region of Lake Magadi in the south to Lake Rudolf on the northern boundary. It is a complex, almost meridional, trough bounded by groups of faults, and frequently with minor troughs and horsts on its floor, which rises from about 2,000 ft. at Magadi to over 7,000 ft. at Longonot north-west of Nairobi, and then sinks again to below 1,500 ft. at Rudolf. Several volcanoes, of which the best-known generally are perhaps Longonot (9,111 ft.), Suswa, and the cauldron at Menengai (7,080 ft.), near Nakuru, form prominent mounds rising from the floor. The walls of the Rift are commonly markedly stepped, though in places, notably along the west flank of the Aberdares and the east flank of the Elgeyo Mountains, the denuded faces of large single faults are prominent and give rise to unusually magnificent escarpments.

Faulting that can be clearly associated with the Rift does not extend for more than a few miles outside the main walls of the trough. Faulting along the equatorial trough that encloses the Kavirondo Gulf, and extends south-westerly through Southern Kavirondo as the Lambwe Trough, is of generally similar age to the faulting in Central Kenya. Lake Victoria is a gentle depression caused by sag over a wide area, probably as a result of the Rift faulting in Kenya on the east and the Albertine rifting in Uganda.

A discussion of the problem of the origin of the Kenya Rift—whether due to tensional or compressional faulting, to upward thrust, or mainly to sub-aerial erosion though possibly along ancient fault lines—cannot be given here. It must suffice to say that recent official mapping of areas including portions of the Rift indicate that it is primarily a relatively recent tectonic feature and that

many of the faults on its eastern side at least are of normal tensional character.

Movement in Western Kenya

The faulting along the Kavirondo Gulf and the sinking of the Nyanza basin have led to tilting and rejuvenation of the sub-Miocene peneplain. Incision as a result of rejuvenation has yielded characteristic V-shaped valleys sunk into the peneplain through which run relatively swift rivers with bars and rapids at frequent intervals.

Coastal Movements

The effect of Pleistocene and Recent movements at the coast are seen, particularly around Mombasa Island, in the fossil and modern coral reefs and in the estuaries of the few rivers. The raising of Pleistocene coral reefs, in some cases to more than a hundred feet above sea-level, was followed by submergence, when the estuaries of the rivers were drowned and wave-cut benches were eroded in the portions of the reefs still exposed. Subsequent raising of the coast relative to the sea brought these benches once more above sea-level and lifted modern coral reefs to the surface.

Mineral Resources

Only two of Kenya's minerals have figured prominently as exports—gold and trona (as soda ash)—though numerous other minerals have been discovered and exploited on a small scale, as may be seen from the following table of production. (*See also*: accompanying Mineral Map.) The industries associated with these other minerals show signs of a healthy growth, and in some cases there is hope that they may develop into prime importance.

Production of Minerals in Kenya

		1945.	1946.	1947.
Gold	*refined troy oz.*	38,517	29,892	21,959
Silver	,, ,,	16,659	5,493	3,859
Soda ash	*long tons*	72,589	84,633	91,368
Salt	,, ,,	15,242	15,388	13,836
Lime	,, ,,	15,037	12,832	11,101
Kyanite	,, ,,	444	2,380	14,448
Coral limestone	,, ,,	930	1,709	1,535
Clay and kaolin	,, ,,	1,627	1,372	306
Diatomite	,, ,,	444	508	724
Gypsum	,, ,,	206	500	649
Talc and soapstone	,, ,,	199	482	292
Pyrite	,, ,,	—	407	—
Asbestos	,, ,,	383	162	573
Quartz	,, ,,	96	135	—
Magnesite	,, ,,	14	60	40
Felspar	,, ,,	108	43	35
Pegmatite	,, ,,	11	30	10
Vermiculite	,, ,,	10	—	0·2
Graphite	,, ,,	3	—	—
Mica	,, ,,	1	—	—

The values of the above products may be grouped as follows:

VALUE OF MINERALS PRODUCED IN KENYA

	1945.	1946.	1947.
Gold and silver	£335,936	£258,985	£190,055 approx.
Soda products	453,236	502,324	682,999
Lime	58,388	51,005	41,843
Other minerals	15,346	26,757	77,810
Total	£862,906	£839,071	£992,707 approx.

Kenya is a young Colony where hitherto the emphasis has been largely on agricultural development, which is perhaps sufficient to account for the somewhat slow development of mineral resources, though official geological mapping and investigation has also not been sufficiently extensive for various reasons. As in many colonial countries progress has been hampered by lack of local or near markets for most of its minerals. Development is also often hindered by long haulages to sites where minerals can be used or to the coast for export. The continued search for minerals has opened up wider and wider stretches of the country to civilisation and has been of value to the indigenous populations in providing work near to their homes and enabling them to sell farm produce easily, and to improve their standard of living by means of the cash received. This has nowhere been so evident as in the goldfields.

Gold and Silver

Gold and silver mining is restricted to areas in which the Nyanzian and Kavirondian Systems are found, i.e., in Nyanza Province and in a smaller area east of the Kisii Highlands. It had been carried out in a minor way for several years in a belt near the Tanganyika boundary before the discovery of the Kakamega Goldfield in 1931, and with it the more intense examination and exploitation of the deposits of the whole of Kavirondo. The discovery was made during a difficult period in the history of the Colony because of agricultural mishaps and general world trade depression, and a few months saw the rapid influx of hundreds of would-be prospectors and miners. Larger financial concerns (*see* Plate I) soon became interested, however, and within a few years gold mining was on a sound footing. The value of gold produced increased steadily until the early years of the World War. Subsequent years have seen a gradual decline owing to loss of personnel and inability to replace or purchase adequate stores and equipment.

The production of gold from Kavirondo has always been predominantly from quartz veins and a few impregnations, though in

the earlier years the proportion of alluvial gold won was higher. No extensive workable alluvial deposits have been found or are likely to occur, though a small alluvial production may be maintained by individual workers.

The fineness of gold won from veins has usually been about 800 to 850, but at mines where non-ferrous sulphides are prominent constituents of the primary ore, bullion of much less refined character has been obtained. At one mine the gold is present in the form of electrum. The quartz veins are commonly of lenticular habit, and range in strike length from a few tens of feet to 2,000 ft. or more. Extension in depth is not uncommonly greater than the surface strike. The payable gold is restricted to more or less well-defined shoots, and the extent of payable ore is usually considerably less than the maximum extent of the quartz veins. The thickness of the veins varies from the size of stringers (of which unusually rich examples have been discovered from time to time) to 20 or 30 ft. The average width of veins worked is, however, probably only 1 or 2 ft. The gangue of the veins is principally quartz, but carbonate, felspar, ilmenite, chlorite, epidote and sericite figure in some. The principal sulphides are pyrite, pyrrhotite, mispickel and chalcopyrite; galena and blende are sometimes present in minor amounts. Tourmaline and scheelite have been found in some of the veins, and fluorite has been recorded from a vein in Southern Kavirondo. Tellurides are of rare occurrence.

The veins have been found within granite cupolas, a little way inside larger granite masses, or usually within about 2 miles from the exposed granite contact. In cases where veins lie further out from the visible contact there is usually evidence that granite lies at relatively shallow depth.

The goldfield area forms part of the sub-Miocene peneplain, and as a whole is characterised by deep weathering. Exposure of many of the gold-bearing quartz veins is poor, and in several cases they were traced only by the use of loaming methods. Mechanical enrichment of the portions of the veins above the water-table has usually been a marked feature, and in several cases collapsed lode rubble has provided rich reserves. Many massive and extensive veins or dykes of white quartz occur, some of which extend over several miles. Though they usually contain some gold, they have not proved in many cases to be of workable tenor. Few of the lode deposits are of great size, and at the present time production is largely maintained by one large mine and a small number of medium-sized mines.

The figures quoted below give a summary of the growth and value of the gold industry, and indicate the effect of the recent war.

PRODUCTION OF GOLD IN KENYA*

Year.	Production.		Total Production. Troy oz.	Value. £
	Alluvial. Troy oz.	Lode. Troy oz.		
1926	—	667	667	72,057 (1926–1932)
1927	—	661	661	
1928	—	707	707	
1929	—	845	845	
1930	—	1,789	1,789	
1931	404	2,765	3,169	
1932	6,015	4,778	10,793	
1933	3,655	10,487	14,147	67,665
1934	3,284	12,655	15,939	83,617
1935	4,073	25,105	29,178	162,904
1936	4,358	44,277	48,635	269,947
1937	3,941	64,729	68,677	379,626
1938	3,740	83,397	87,137	499,601
1939			104,076	607,753
1940			77,243	648,783
1941			72,148	606,042
1942			56,771	476,879
1943			43,118	378,989
1944			42,259	354,976
1945			38,517	333,259
1946			29,892	257,942
1947			21,959	189,397

* *Quantities are quoted as unrefined ounces from* 1926 *to* 1939, *and as refined ounces for later years. Value of refined gold produced up to* 1947 : £5,389,437.

ROYALTIES*

1939	No royalties collected.
1940	£24,600 approximately.
1941	£31,301 ,,
1942	£25,513 ,,
1943	£21,688 ,,
1944	£22,104 ,,
1945	£16,639 ,,
1946	£14,495 ,,
1947	£5,541 ,,

* *These are gross figures. They are subject to reduction and readjustment on account of refunds made in accordance with the Mining (Gold Royalty) Regulations,* 1941.

CLAIMS, ETC.

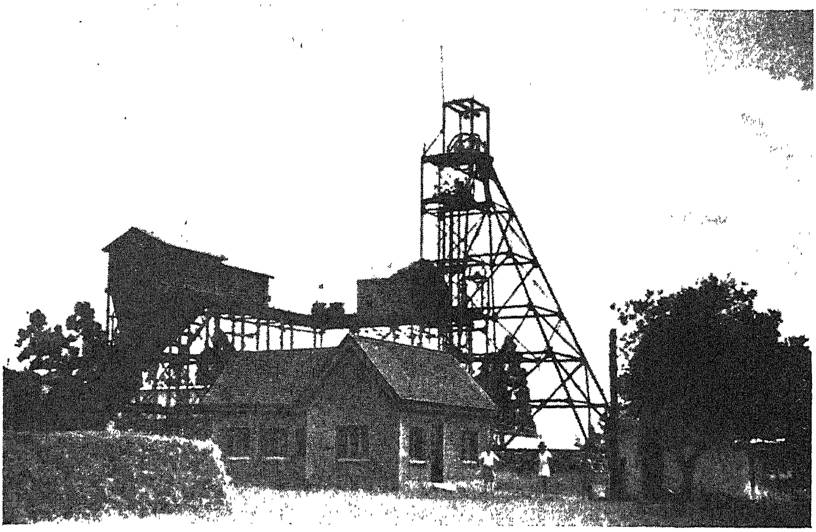
Year.	Leases.	Claims.		Exclusive Prospecting Licences and Special Licences.
		Lode.	Alluvial.	
1945	6	1,618	10	3
1946	7	1,516	84	1
1947	7	1,564	104	1

LABOUR EMPLOYED ON GOLD MINING

	1945.	1946.
European . . .	97	87
Asiatic . . .	99	100
African . . .	3,650	3,098

Silver obtained during the refining of the gold exported is relatively unimportant ; appropriate figures are given below :

PLATE I.



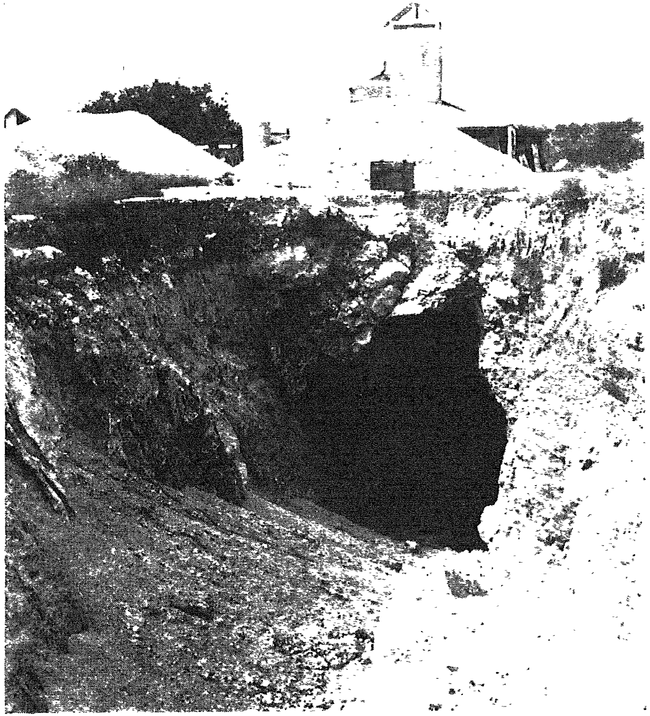
Rosterman Gold Mine, Kakamega.

PLATE II.

Lake Magadi and the Factory of Magadi Soda Co.

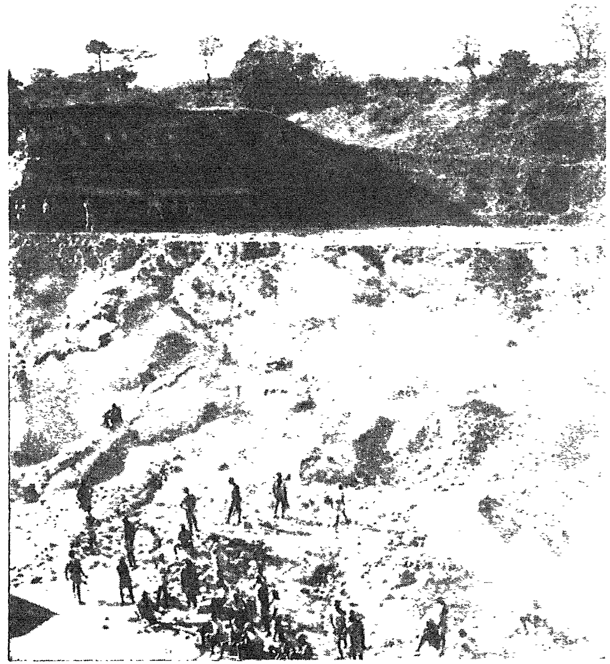
[facing page 288

PLATE III.



OLD WORKINGS ON THE VITENGENI GALENA-BARYTES VEIN.

PLATE IV.



DIATOMITE DEPOSITS, KARIANDUSI VALLEY, NEAR GILGIL.

facing page 289]

PRODUCTION OF SILVER IN KENYA

Year.	Production. Troy oz.	Value. £
1926-1945 . .	—	13,776
1945 . . .	16,659	2,677
1946 . . .	5,493	1,045
1947 . . .	3,859	658 approx.

Soda Products

The trona of Lake Magadi has been worked since 1919 by the Magadi Soda Co., Ltd., now a subsidiary of I.C.I. The trona is calcined in large rotary kilns at the factory beside the lake (*see* Plate II), the calcined material containing on an average between 97 and 98 per cent. of sodium carbonate. During later years there has also been a considerable output of common salt, sodium bicarbonate and washing soda at the factory, and during the war years sodium fluoride (a constituent of the lake salts) was also extracted.

The export of Magadi products is a considerable item in the economy of the country, as is shown by the following figures.

VALUE OF PRODUCTION AT MAGADI SODA WORKS

	1944.	1945.	1946.	1947.
Soda ash, salt, etc. .	£398,797	£453,236	£502,324	£682,999

Other Minerals of Economic Importance

Notes on minerals and rocks worked or likely to be worked for export or for local consumption are given in the following paragraphs.

Arsenic.—Mispickel occurs in some gold-quartz veins, and in certain cases is a prominent constituent. There is no doubt that, with correctly designed plant, a small production of white arsenic could be made concurrently with the operation of some of the veins as gold properties.

Asbestos.—Anthophyllite asbestos has been discovered at several localities, for example, at Kinyiki, near Mtito-Andei, in Southern Kitui, and in West Suk. Production of note has come only from Kinyiki and Suk, and consumption has been local. During the war an asbestos-cement tile and sheet industry was set up in connection with the production in West Suk, and continues to operate. Long-fibred material is present in both main occurrences, but as is not unusual with anthophyllite, the strength is not suitable for spinning. Crocidolite has been discovered in southern Machakos, near Sultan Hamud, but has not been worked.

Barytes.—A lode of barytes (associated with lead, zinc, and feeble copper mineralisation) occurs at Vitengeni north-west of Kilifi on the coast, and a small output came from it some years ago. Its maximum width is more than 30 ft. (*see* Plate III). Near the surface the barytes is variably and patchily ironstained, but clean white mineral can be obtained by handpicking ; at lower levels abundant supplies of white material may be expected. Any of the material would be suitable for well-drilling mud and, after treatment, for

paint manufacture. During the war a small amount was used by local industries.

Other occurrences of barytes, apparently of no economic interest at present, are known in the southern part of the Coast Province, in South Kitui and in South Kavirondo.

Bentonitic Clays.—Clays with affinities to bentonite occur as intercalations in lake beds that form part of the generally volcanic sequence east of Nairobi, and in Pleistocene deposits at several localities north of Mt. Kenya. The better quality clays are soapy when moist and swell to about three times their original volume when wetted. Research at the Imperial Institute and the British Museum suggests that the clays are composed predominantly of nontronite and illite. Nontronite clays have since been reported from other localities in the Tertiary volcanic areas.

The clays have been used in Kenya principally as moulding-sand bonds, and interest in England has been stimulated so far as the processed clays are concerned. It is considered that the fine fractions could, if offered at a reasonable price, find a ready sale there.

Beryl.—This mineral is found as a minor constituent of mica-pegmatites in the Basement System. Some years ago a pegmatite containing a large "blow" of beryl was discovered and mined in the Machakos district, but such occurrences are fortuitous and rare.

Brick-Earths and Clays.—Bricks and tiles have been made for many years at certain localities, though nowhere on an extensive scale. During the war small industries arose at other localities, largely because prisoner-of-war labour was available. The recent appointment of a ceramics specialist to the Industrial Research Board is expected to lead to improvements in quality and quantity of the bricks and tiles produced.

Building Stones.—General purposes building stones of good quality are not abundant near most of the centres of population, and consequently it is to be anticipated that concrete construction will eventually usurp their place. Coral blocks have been largely used around Mombasa, while at Nairobi a thin band of tuff has provided stone for the greater proportion of the buildings. Other centres are poorly supplied with building stone, and usually concrete or brick constructions are necessary. Rocks suitable for concrete ballast are accessible within reasonable distance of most places where extensive building appears likely at present.

Ornamental stones, with the exception of Basement System marble which has been extracted near Turoka on the Magadi branch line, have been little worked, though numerous fine stones among the Basement System rocks and goldfields granites would be suitable for such use.

Cement.—There is a considerable and increasing consumption of Portland cement in Kenya and adjoining territories, but until recently it has been considered more economic to import cement or clinker rather than set up manufacturing plant. During the

last few years considerable attention has been given to the question of installing a cement factory, and most localities have been examined where abundant limestones and suitable argillaceous material occur; it is hoped that eventually cement will be produced in the country. Gypsum for admixture during the grinding of the clinker is available, though it requires transport over long distances.

Copper.—Traces of copper minerals have been found at several localities in Basement System terrain in the eastern part of Central Province. At Lugard's Falls, where 5 per cent. ore was prospected, the copper occurred in a pegmatite mineralised with chalcopyrite. It is unlikely that such deposits will become of economic interest.

An extensive copper deposit has been known for some years at Macalder Mine in Southern Kavirondo, though the mine has so far only extracted gold from the oxidised zone. The ore-bodies are a branching series of lenticular veins extending over more than 200 ft. They are often more than 20 ft. in width and consist of massive banded sulphides. The oxidised caps, carrying free gold, are about 120 ft. in depth, and at their bases there are thin zones of secondary copper minerals.

The primary ore is a fine-grained, streaky, granular aggregate of pyrite, pyrrhotite, chalcopyrite, magnetite, arsenopyrite, zinc blende and galena, with interstitial calcite. Chlorite is often plentiful in the vein margins. Gold in the ore is present as electrum, and is closely associated with the galena. A small percentage of cobalt has been determined in assays.

Another copper occurrence, as yet unprospected, has also been discovered near Kitere, some miles north-east of Macalder Mine, in the central part of Southern Kavirondo.

Diatomite.—Extensive deposits of diatomite are known in Pleistocene lake beds at various points in the Rift Valley. Occurrences near Gilgil and along the Magadi branch line have been worked for several years. That at Gilgil is noteworthy in containing several bands of diatomite, one of which is more than 100 ft. in thickness where best developed, and of unusual purity (*see* Plate IV). Recently a local company was formed to work this band, with a view to processing the material for export for use as a filter aid and as an insulating medium. Previously almost the entire production had been absorbed by local soap factories. Experiments on the use of the material for various other purposes, such as dusting powders, in tiles, etc., lend hope that eventually the diatomite will find wide uses.

Dolomite.—Basement System marbles with magnesia content approaching that of dolomite were found during the survey of the Taita Hills, near Voi.

Felspar.—This mineral is available in the numerous pegmatites of the Basement System. A few of the larger pegmatites, and notably one at Kinyiki, have been worked for some time, the felspar being used in ceramics factories in Nairobi.

Garnet.—At certain horizons in the Basement System garnet occurs as scattered crystals of varying size or as massive bands. Concentrations of crystals liberated from their matrix are found in some stream courses, and recently a prospector in Machakos worked such a source and marketed garnet powders and cloths.

Melanite garnets have been found in carbonatites and ijolites in Nyanza Province. Gem quality garnets have occasionally been found in Basement System rocks, but are of sporadic occurrence only.

Graphite.—Rocks containing graphite are known in both the Basement System and in the goldfields formations. The latter are, however, of restricted occurrence and of a type unlikely to be of economic interest. Graphite-schists containing up to 25 per cent. of graphite were worked many years ago in the Basement System rocks of the Machakos district, and in recent years a small production has been made from the same source. More extensive deposits of graphite-gneisses were discovered in 1940, during the survey of the Mtito-Andei-Tsavo area. Deposits in Southern Kitui have been explored and tentatively worked during recent years, but are handicapped by distance from rail and permanent water. The deposits at Tsavo are more favourable, being adjacent to the railway and permanent water. The graphite is contained in several, often thick, parallel bands that extend over many miles. Over the portion tested by assay the average carbon content was found to be a little under 6 per cent. though portions of some bands are considerably richer. The deposits were worked in the area near Tsavo Station during recent years, the best product obtained having a carbon content of about 92 per cent. with good proportions of large flakes.

Gypsum.—Gypsum deposits of economic size occur in the northern facies of the Jurassic Sediments and as the desiccated remains of Tertiary and Pleistocene lakes and marshes. These include two deposits in the Tula Valley which have been worked for some years, and occurrences at several localities in the eastern part of the Northern Frontier District.

The two deposits in the Tula Valley are a few miles west and south of Garissa on the River Tana. One deposit consists of pinkish aggregates of gypsum in clays, and the gypsum produced has been consumed by a local cement clinker grinding factory. The other deposit consists of a continuous band of white gypsum in clays. Though white, this gypsum is actually slightly less pure than that of the other locality. The production has been consumed locally in the manufacture of plaster of Paris and chalks.

Reserves are considerable, but the value of the mineral is reduced by the great distance it must be transported (mainly by road) to reach centres of population. Export is unlikely except by the opening of some form of river transport down the River Tana.

Iron Ore.—Deposits of iron ores have been prospected, but are probably too small to justify working, though some may be of use at a future date. They include haematite-magnetite-schists, magnetite segregations (south Machakos), magnetite sands on the shores of Lake Victoria, pyritic lodes and their gossans in Nyanza Province, and some banded ironstones in the northern and southern portions of the same Province.

Kaolin.—Several deposits of kaolin have been discovered east of the Rift Valley, notably near Fort Hall, in the southern Machakos district and in the Ndi Hills a few miles north of Voi. All are the result of the weathering and disintegration of gneisses of the Basement System. For some years a production has been maintained for use in local ceramics factories, both for pottery and for refractories. It is to be anticipated that as more of the Basement terrain is covered by geological survey other deposits of kaolin will be discovered.

Kisii Soapstone.—There are several scattered occurrences of soapstone in Southern Kavirondo, the material available being of varying quality. The rock consists normally of a mixture of sericite and kaolin but grades into more complex types containing in addition epidote, chlorite, quartz, etc. Frequently the stone is closely jointed, though at some localities large blocks can be obtained.

The stone has been quarried on a small scale for many years by Africans, and worked as carvings. During more recent years a mining company has quarried it more extensively and installed crushing and air-separation plant. The air-floated product has been largely consumed by local soap factories. Attempts have been made to use the stone in the worked solid form, for it is readily cut and shaped, and when suitably baked develops a surface frit that renders it much less porous.

Kyanite.—Gneisses and schists containing kyanite occur at various localities where Basement System rocks are exposed, particularly in the Machakos district and in the area south-west of Tsavo. Deposits in Machakos have been worked on a small scale, but the kyanite usually occurs there in isolated crystals. This and the cost of transport required render exploitation unprofitable, though at certain localities unusually large fine blue crystals have been found and sold as collectors' specimens.

Numerous kyanite-bearing rocks were mapped in 1940-41 in the area between Tsavo and Taveta during an official reconnaissance. At Murka Hill, a few miles north-east of Taveta, unusually fine deposits were noted that were later pegged and worked by a local company. Here a thick band consisting almost entirely of radiate masses of kyanite is intercalated among quartz-kyanite -schists and -gneisses. With little hand-selection it is possible to extract rapidly large cargoes of kyanite of more than 90 per cent. purity.

The kyanite has been successfully used for the local production of mullite bricks and other refractories, and a growing export trade

established. The question of conversion of the kyanite to mullite prior to export is being actively considered, and it appears likely that calcination will become standard practice.

Reserves of the mineral are considerable, and, with the depletion of sources of kyanite and sillimanite elsewhere, there are hopes of a bright future for the Murka deposits.

Lead.—For some years a system of galena-barytes veins, containing pockets of zinc-blende and traces of copper minerals, has been known in the Mesozoic sandstones at Vitengeni, north-west of Kilifi in Coast Province. The principal vein has a relatively short strike, but at its thickest section is more than 30 ft. wide. (*See* Plate III.) The galena content over the vein is apparently about 7 or 8 per cent., with silver ranging up to about 8 oz. per ton of galena concentrates. There was a small production some years ago, and during the recent war a small amount of galena was taken from stacked ore for local use.

Other traces of galena mineralisation are known in the Mazeras district where a deposit was worked by the British East Africa Company in 1892.

Limestone.—There are five principal lime-burning concerns in the Colony—at Mombasa, Turoka, Muhuroni, Homa Bay on the Kavirondo Gulf, and at Kiambu, near Nairobi. Production, owing to the limitation of supplies of Portland cement, increased rapidly during the war years. The limestones worked at the localities named are respectively Pleistocene coral, Basement System crystalline limestones, Miocene lake limestone and Pleistocene lake limestones (two). The Basement System limestones have a variably high magnesia content, but the remainder are magnesia-poor types.

Resources of limestone in the Colony are extensive. Basement System marbles are widespread, though many are inconveniently placed with respect to transport. Miocene limestones and carbonatites form a large reserve in Kavirondo, and kunkar deposits east of the Rift, and Jurassic limestones and coral near the coast, are available.

Magnesite.—This mineral occurs as veins in dunite intrusions at Kinyiki Hill, Kipiponi and near Magongo Hill in South Kitui, and near Merti in the Northern Frontier District. The occurrence at Kipiponi has been prospected, and that at Kinyiki worked for a short period. The veins at the latter locality are sometimes 2 ft. or more in thickness and extend over many yards, but more usually they consist of a great number of branching veinlets. The proportion of magnesite to host rock in more favourable portions of the Hill reaches 30 per cent. A small quantity of high grade magnesite was extracted during the early war years, as well as a considerable tonnage of somewhat less satisfactory material.

Manganese.—Deposits of manganese ores were discovered about 30 years ago at Mrima Hill, south-west of Mombasa, but have not been worked. The ores consist largely of psilomelane associated

with a proportion of iron oxides. Similar ores are said to have been struck in boreholes for water in other parts of the southern Coast Province.

Other deposits of manganese in coastal sediments have been investigated at Chonyi, west of Kilifi. The ores resemble those of Mrima, but it is probable that pockets of pyrolusite are also present.

A small deposit of pyrolusite was discovered some 30 years ago in a Pleistocene lake basin near Gilgil in the Rift Valley. The deposit was small, but consisted of material that could be readily beneficiated by washing and screening. During the war it was largely worked out by officers of the Mining and Geological Department, when manganese dioxide was required for use as a drier in locally-made paint.

Mica.—Sheet mica has been worked sporadically in Kenya, but production has never been large. The deposits occur in pegmatites, usually in the Basement System. The principal localities where they have been worked are West Suk, Sultan Hamud district, Kierra, the Tsavo Valley, and west of the Taita Hills.

The mica extracted has usually been of the ruby or brown muscovite type, though some green muscovite has also been produced. The industry has been hampered generally by lack of capital, and by the inexperience of operators in the cutting and grading of mica.

Mineral Pigments.—During the war paints and washes were difficult to obtain and recourse to local materials was necessary. Reds, yellows and browns were readily obtained from several localities from oxidised clays and other superficial sediments or the material obtained by calcining them. A green pigment was obtained by using a chloritic claystone from near Lodwar in Turkana, and local graphite was used in black paints.

Pumice.—For some years small quantities of pumice have been dug in the Naivasha district of the Rift Valley. Reserves are probably considerable, but consumption at present is small.

Pozzolana.—Various mineral aggregates among the rocks of the Highlands volcanics have pozzolanic properties, some of a high standard. During the war, efforts were made to interest builders in the use of such materials.

Pyrite.—The only economic deposits of pyrite known occur in the Nyanza Goldfields. At two places in North Kavirondo there are extensive gossans overlying veins and impregnations rich in pyrite or mixtures of pyrite and pyrrhotite. Both have been examined in connection with their small gold content, but neither has been worked.

Pyritic lodes are also associated with the copper ore-bodies at Macalder Mine in South Kavirondo. A small production has been made for the manufacture of sulphuric acid at Nairobi.

Quartz.—For some time quartz has been quarried from a pegmatite at Kinyiki Hill for use in local ceramics factories. Some years

ago one or two large crystals of quartz of excellent piezo-electric quality were found in eluvials at the western foot of the Hill. Extensive working in the superficial deposits by a prospector revealed a small number of additional crystals. Subsequently the Mining and Geological Department examined the deposits closely and discovered the source vein, but underground working failed to reveal pockets of crystals. A country-wide search was made for other quartz crystal localities, and several were found where occasional crystals could be recovered. At Tseikuru, in North Kitui, several hundreds of crystals were found in pegmatites or eluvials derived from them. Most were, however, unsuited for piezo-electrical purposes.

Sapphire.—A small quantity of gem quality sapphires was recovered a few years ago from eluvials at Kinyiki Hill. The stones are derived by the disintegration of large corundum crystals formed at the contact of dunite and hornblende-schists. Corundum crystals as much as 4 ft. in length have been found, though the greater part of such crystals is composed of grey or finely-cracked material.

Talc.—Deposits occur as metamorphic products of ultrabasic intrusions and magnesian limestones in the Basement System. They vary from pure talc to schists containing actinolite or anthophyllite. Deposits have been worked in Machakos and West Suk, and a small and growing production has been maintained from the former locality for some years, largely for local consumption. It is anticipated that more extended survey will reveal numerous other talc deposits.

Titanium Ores.—Ilmenite is of widespread occurrence throughout Basement System terrain, occurring as sporadic crystals and aggregates in pegmatites. No deposits so far discovered are likely to be of economic interest. Black sands found near the mouths of the few rivers that reach the coast contain much ilmenite together with a small proportion of rutile.

Vermiculite.—Numerous deposits of vermiculite have been located by prospectors, though only one deposit—at Kinyiki Hill—has yet been worked, and that on a small scale. The other deposits are situated in the Machakos district, at Kipiponi in South Kitui, and in West Suk. Some are lenticular and intercalated in the Basement System, others (for example at Kipiponi and Kinyiki) are contact deposits at the margins of schists and dunite. It is likely that as the survey of Basement System areas is more widely extended more deposits of vermiculite will be discovered.

A company has recently been formed to work the deposits in the Machakos district. Although only local consumption can be looked for at present, the possibility of a future export trade cannot be excluded.

Minerals of No Present Economic Value

The following notes deal with minerals that occur in Kenya, but which have not been worked or are uneconomic.

Alum is occasionally found condensed around fumaroles in the Rift Valley. *Amblygonite* has been found as a rarity in Archaean pegmatites. Small *apatite* deposits were discovered by the Survey a few years ago in carbonatites at Ruri in South Kavirondo. The maximum apatite content found was about 30 per cent. *Cassiterite* has been found in small quantities in gneisses near Broderick Falls, and as traces in Kisii sandstones. Low grade *chrome iron-ore* was discovered some years ago in the southern Embu district. The occurrence of a thin vein of *cinnabar* associated with the galena-barytes vein at Vitengeni has been known for some years. During the war the area around the locality was closely prospected, and thin veins and impregnations of cinnabar were found over a small area and to a shallow depth. The maximum tenor of samples was about ½ per cent. Thin seams of *coal* have been noted in drill-hole cores from the Permo-Trias sediments of the coast hinterland, but so far no evidence has been obtained that workable seams may exist. *Columbite* (*-tantalite*) is known as a sparse accessory mineral in mica pegmatites.

It is reported that *gemstones* (a ruby and some diamonds) were found about 25 years ago in gravels in the Chania River at Thika. Re-examination of the gravels by the Survey revealed the presence of ruby, topaz and chrysoberyl, as well as less valuable stones. A few small diamonds have also been recovered in the Kakamega area during the washing of gravels for gold. Moonstones are known in river gravels at the coast, associated with small fragments of gem-quality green and blue kyanite.

Traces of *molybdenite* were found some years ago in syenite in Western Maragoli, and during the survey of the Maralal area, north of Mt. Kenya, a pegmatite containing molybdenite was found but considered of no economic interest. *Monazite* is a minor constituent of black sands found at the mouths of rivers on the coast.

Nepheline is of widespread occurrence in Tertiary lavas, but it is unlikely to become of economic importance except in more coarse-grained plutonics. Urtites and ijolites near Homa Bay might possibly yield supplies. Abundant reserves of *olivine* are available in the dunite at Kinyiki Hill.

Scheelite has been found as an accessory mineral in a few of the gold-bearing veins of Kavirondo. It is probably present in many more, but has remained undetermined. Small supplies of native *su phur* and sulphur-impregnated tuffs occur around an extinct fumarole near Naivasha in the Rift Valley. The average sulphur content has been estimated at about 12 per cent. Fluvial concentrates of *zircon* have been reported in valleys draining the coastal hills, and at Songhor.

WATER SUPPLY

The water supply establishment in Kenya forms part of the

Public Works Department. Assistance formerly given by the Geological Survey was mainly confined to identifications and correlations. More recently extensive surveys have been made in certain areas where water problems arise and it is hoped that in future it will be possible to continue with such surveys, which, while being of a reconnaissance nature so far as geological and mineral conditions are concerned, should assist and quicken the work of the water geologists.

Post-war Activities of the Geological Survey

Immediately after the war a scheme was evolved to meet the need for greatly expanded geological service in the Colony. It was proposed to carry out detailed and reconnaissance surveys over the greater part of the southern half of the country. Limitations of staff have made it impossible to start the scheme with any hope of completing the task as originally planned, but a beginning has been made, and areas in Central and Nyanza Province have been surveyed. As staff becomes available the work will continue with the mapping of other potentially mineralised areas, as well as of areas in which economic minerals are already known to occur, and those in which hydrological and agricultural factors are of prime importance. Special attention is required for the known goldfields and possible extensions of them, where the completion of detailed mapping already begun is required. Detailed surveys are also required in other parts of the country in areas where minerals of potentially large economic value occur. As much of the work as possible will be carried out on a degree or quarter degree sheet basis. The sheets will contribute to the eventual covering of the whole country by official geological maps and smaller scale summary maps based on them. The areas already surveyed geologically by official geologists are indicated on the map facing p. 277, which gives an idea of the magnitude of the task that still faces the Geological Survey.

During the war, usually without adequate facilities, considerable work was done on the determination of the properties of minerals and ores with a view to their uses and beneficiation. In 1945 steps were taken to make available a fully-equipped mineral and ore testing laboratory, and it is hoped that in a short time the laboratory will be in a position to carry out any work required by any branch of the mineral industry of the country. In the past facilities have been placed at the disposal of mineral operators to enable them to carry out research on processing in the laboratories in co-operation with officers of the Department. This policy has had excellent results, and its continuance is highly desirable.

Mineral Development in the Future

Although the mineral production of Kenya has not been an outstanding feature in the past, it must not be forgotten that much of the Colony has not been geologically surveyed, and even in areas

where minerals are known, prospecting has often been inadequate owing to insufficient finance or lack of experience on the part of operators. With the expansion of geological services it is not unlikely that mineral discoveries will become more frequent, and it is perhaps reasonable to hope that stable and valuable mineral industries will arise.

For the near future the Kavirondo Goldfields and Lake Magadi will continue to furnish their quota of minerals, and the expansion of the production of minor minerals can be confidently expected. In the case of some—kyanite, copper, diatomite and graphite may be taken as examples—there are grounds for hoping that a few years may see the establishment of considerable and regular production for export.

List of Official Reports and Maps of Regional Interest

The list includes areas mapped since 1933, when detailed mapping in the goldfields began. The appropriate number of most of these areas is indicated on the accompanying map facing p. 277. Titles are abbreviated.

Area. *Report or Map.*

1. Loldaika-Ngare Ndare area. Report No. 1. R. Murray-Hughes, 1933. (No map.)
2. Lolgorien area. Report No. 2. R. Murray-Hughes, 1933. (Scale 1 : 350,000.)
3. Western half of Kenya. Report No. 3. R. Murray-Hughes, 1933. (Scale 1 : 1,000,000.)
4. Map of the Kakamega area. R. Murray-Hughes, 1933. (Scale 1 : 62,500.)
5. Map of the Kakamega area. D. Harverson, 1934. (Scale 1 : 67,220.)
6. No. 2 Mining area, Kavirondo, north-west quadrant. Report No. 4. C. S. Hitchen, 1936. (Scale 1 : 63,360.)
7. No. 1 Area, North and Central Kavirondo. Report No. 5. W. Pulfrey, 1936. (Scale 1 : 125,000.)
8. No. 2 Mining area, Kavirondo, north-east quadrant. Report No. 6. C. S. Hitchen, 1937. (Scale 1 : 63,360.)
9. No. 2 Mining area, Kavirondo, south-west quadrant. Report No. 7. W. Pulfrey 1938. (Scale 1 : 63,360.)
10. Nairobi. H. L. Sikes, 1939. (Scale 1 : 125,000.)
11. Maramma, west Kakamega. Report No. 8. W. Pulfrey, 1945. (Scale 1 : 63,360.)
12. Maragoli, North Kavirondo. Report No. 9. W. Pulfrey (1946.) (Scale 1 : 63,360.) (Printed but not yet published.)
13. Migori Gold Belt and adjoining areas, South Kavirondo. Report No. 10. R. M. Shackleton, 1946. (Scale 1 : 125,000.) (Two maps.)
14. Eight geological maps illustrating Report No. 10. R. M. Shackleton, 1946. (Scale 1 : 25,000.)
15. Nanyuki and Maralal. Quarter degree sheets 27 S.E., 28 S.W., 35 N.E. and S.E., 36 N.W. and S.W. combined. Report No. 11. R. M. Shackleton, 1946. (Scale 1 : 250,000.)
16. Nyeri area. Quarter degree sheet 43 N.E. Report No. 12. R. M. Shackleton, 1945. (Scale 1 : 125,000.)
17. Mtito Andei-Tsavo area. Report No. 13. J. Parkinson, 1947. (Scale 1 : 250,000.)
18. Area west of Kitui township. Quarter degree sheet 52 N.E. Report No. 14. J. J. Schoeman. (Scale 1 : 125,000.) (In the press.)
19. Geology of Northern Kenya. Report No. 15. F. Dixey. (Scale 1: 2,000,000.) (In preparation.)
20. Sotik District. Quarter degree sheet 42 S.W. Report No. 16. J. J. Schoeman. (Scale 1: 125,000.) (In preparation).

OBITUARIES

Dr. A. K. Coomaraswamy.—Earlier this year it was our painful task to record the deaths of Dr. Parkinson and Dr. Falconer, two of the pioneers of the Mineral Surveys of the Colonies carried out under the auspices of the Imperial Institute. We now record with deep regret the death of yet another of these pioneers, Ananda Kentish Coomaraswamy, D.Sc., F.L.S., F.G.S., M.R.A.S., who died at Needham, Massachusetts, on September 9, 1947.

Dr. Coomaraswamy, who was born in Ceylon in 1877, was educated at Wycliffe College, Stonehouse, Gloucestershire, and at University College, London, where he obtained his doctorate and was made a Fellow. In 1903 he went to Ceylon to direct, under the supervision of the Director of the Imperial Institute, the first official Mineral Survey of that island and he held this appointment until December 1906. His reports on the geology and mineral resources of Ceylon are his first and only scientific publications, for his abiding interests lay in other fields and all his subsequent writings were on art, sociology and metaphysics, subjects to which he devoted his very considerable talents for the rest of his life. He was a Nationalist with cultural rather than political ideas. He initiated the movement for national education in Ceylon, the teaching of the vernacular in all schools, and the revival of Indian culture, and he became the President of the Ceylon Social Reform Society with these objects in view. He was also one of the founders of the Royal Indian Society. His last appointment was as Fellow for Research in Indian, Persian and Mohammedan Art at the Museum of Fine Arts, Boston, Mass. His publications are numerous.

A. N. Gray.—It is with deep regret that we record the death at his home at St. Leonards on Sunday, October 5, 1947, of Mr. A. N. Gray, aged 67.

After the 1914-1918 war, during which he served in the Ministry of Munitions, he became interested in fertilisers and was instrumental in the formation of the Fertiliser Manufacturers' Association, Ltd. He also became the first honorary secretary of the International Superphosphate Manufacturers' Association and held that post until ill-health compelled him to retire in July 1946. In 1930 he published the first edition of his valuable *Phosphates and Superphosphates*, which is now in its second edition. During the recent war he was Deputy Fertiliser Controller.

In 1921 Mr. Gray joined the Chemical Industries Technical Committee of the old Imperial Mineral Resources Bureau as representative of the Fertiliser Manufacturers' Association, Ltd., and retained his membership of the new Chemical Industries Consultative Committee of the Imperial Institute on the amalgamation of the Bureau with the Mineral Resources Department of the Institute. He was still a member of this Committee at the time of his death, and his wide experience in matters connected with the fertiliser

trade, which was always placed freely at the disposal of the Institute, was most helpful and greatly appreciated.

ABSTRACTS AND NOTES

Rapid Development of Kenya's Kyanite Industry.—The economic development of the recently discovered deposits of kyanite in Kenya constitutes one of the most notable features of the Colonial non-metallic mineral industry in late years.

In 1938 kyanite of excellent quality was forwarded to the Imperial Institute from an unspecified locality in Kenya (see this BULLETIN, 1938, **36**, 493-498), but the mineral was of the bladed variety and did not attract economic interest. In 1940 Dr. Parkinson began a detailed survey of the Mtito Andei-Tsavo area of south-eastern Kenya, and as a result discovered numerous occurrences of kyanite-bearing rocks in that area (see *Report No.* 13, *Geological Survey of Kenya,* 1947). Two years later, in 1942, the deposits were pegged, and by 1947 production had exceeded 14,000 tons. Preliminary estimates indicate that the output for 1948 will be considerably greater than that for the previous year, and further suggest that the Colony is rapidly overtaking India as the largest single producer of kyanite in the world.

During the war production was commenced in Kenya on a small scale, partly for local requirements and partly for export to the United States. Since then, however, world consumption of kyanite in the manufacture of refractories, electrical porcelain, and numerous other products, has greatly increased, and has led to an unprecedented demand for the mineral for use in the United Kingdom, the United States, and various European countries. The importance of the Kenya deposits at the present time is therefore apparent, and, as comparatively little information concerning them has so far been put on record, the following notes based on published information and on data communicated to the Imperial Institute by Dr. W. Pulfrey, Senior Geologist, may be of interest.

The deposits which are being worked are located on claims held by Sir Charles Markham on Murka Hill, some 30 miles S.E. of Kilimanjaro. The mine is only about 3 miles north of the Taveta branch line which is 178 miles from Mombasa.

In this area there are numerous occurrences of kyanite-bearing rocks in what Dr. Parkinson described as the argillaceous sedimentary group of the Basement System (Archaean). Subsequent work, however, and particularly the discovery of the intimate association of intergrown topaz and very rare nests of pyrite with the kyanite, as well as the occurrence of the kyanite in one place passing down into a joint plane, would appear to indicate that the kyanite is partly of hydrothermal or pneumatolytic origin rather than entirely metamorphic.

The kyanite occurs in a series of siliceous gneisses and kyanite-bearing gneisses dipping about 30° N.E. One of the kyanite-rich beds forms the crest of the hill which extends, at a height of about 300 ft. above the surrounding plain, over approximately 1,000 yd., and as a low ridge continuing to the north of the hill. Large segregations of kyanite, ranging up to several hundred tons in weight occur, particularly at the southern end of the hill, where they have probably fallen from outcrops on the ridge. The latest information available is to the effect that the kyanite *in situ* probably occurs as separate lenses on one horizon running more or less on the crest of the hill. The huge masses of kyanite so far worked on the west flank and at the foot of the hill are regarded as fallen blocks. The mode of occurrence of the kyanite is such that little can be seen of the *in situ* material, so that a diamond-drilling programme would be required in order to determine what actually lies below the present horizon or whether other lenses lie on the same horizon down dip.

It is pointed out in Dr. Parkinson's report that kyanite deposits closely similar to those at Murka have been described from Nyasaland (see this BULLETIN, 1938, **36**, 495).

The Kenya kyanite is of the bluish type of mineral. Heavy liquid separation of the ground material yielded heavy fractions of kyanite with a few rutile grains, and light fractions usually of quartz, but sometimes with a little mica and felspar. Certain material previously thought to be quartz has been shown to be topaz; the high alumina contents noted have been proved to be due to the presence of corundum.

In the following table an analysis (No. 1) is given which is more or less typical of the average composition of the material now worked, together with some comparative analyses. It is interesting to note that the average overall Al_2O_3 content of consignments shipped between June, 1946, and February, 1947, was 61·51 per cent.

KYANITE ANALYSES

(*Per cent.*)

	1	2	3	4	5
SiO_2	37·38	35·58	36·8	34·66	31·07
Al_2O_3	59·65	61·00	63·2	60·84	65·52
Fe_2O_3	0·56	0·30	—	0·07	1·50
MgO	0·07	0·08	—	n.d.	0·04
CaO	0·27	0·12	—	n.d.	0·34
Na_2O	n.d.	0·24	—	n.d.	n.d.
K_2O	n.d.	0·12	—	n.d.	n.d.
Loss on ignition	0·60	0·60	—	0·90	—
TiO_2	1·09	1·48	—	1·18	1·43
Total	99·62	99·52	100·0	97·65	99·90

1. *From a 300-ton consignment.*
2. *Hand sample.*
3. *Theoretical.*
4. *Indian kyanite.*
5. *Calcined Indian kyanite.*

The major part of the impurity in Kenya kyanite is TiO_2 (as rutile) which is said to have no adverse effect in use.

A little of this kyanite has been calcined locally for domestic consumption in East Africa, and research work by the East African Industrial Research and Management Boards on the conversion of the kyanite to mullite has shown that it is possible to produce a grog with mechanical strength comparable to that of commercial samples of mullite.

Five typical silica and alumina contents of the converted Kenya kyanite are as follows :

ANALYSES OF CONVERTED KENYA KYANITE

(*Per cent.*)

	1	2	3	4	5
SiO_2 . .	36·53	—	34·15	35·99	34·29
Al_2O_3 . .	61·84	62·34	64·15	60·79	62·45

The bulk of the production so far has been exported in the raw form, but plans are in hand for the erection of an oil-fired rotary converter at Mombasa so that calcined kyanite (mullite) may be offered on the market. Production to date has been as follows :

PRODUCTION AND VALUE OF KENYA KYANITE

	Quantity. (*Long tons*)	Value. (£)	Average Value. (*per ton.*) £ s. d.
1943	287	1,000	3 9 0
1944	607	2,124	3 10 0
1945	444	1,624	3 13 0
1946	2,380	9,428	3 19 0
1947 (Sales) . .	14,448	54,225	3 15 0

Exports to date have been chiefly to the U.S.A., the United Kingdom and Belgium, together with lesser amounts to Palestine, Australia, Holland, France, Sweden and Denmark.

E. R. V.

Biogeochemical Prospecting for Copper and Zinc.—Although the idea of utilising the traces of metals found in plants as a means of prospecting has been known for many years, and work in Sweden and Finland inspired by the late V. M. Goldschmidt has had promising results, general progress in this field has been rather slow. A useful contribution to the subject has recently been made in British Columbia by H. V. Warren and C. H. Howatson (*Bull. Geol. Soc. America*, 1947, **58**, 803-820), which it is hoped will stimulate further research. These investigators differ from most earlier workers in that they have used ordinary chemical assaying techniques, rather than spectrographic methods, and they have begun by establishing a most important comparison between the amounts of copper and zinc which may be expected over unmineralised rocks, and the

higher concentrations which occur over economic deposits of these metals. At five mining localities in British Columbia samples of the leaves, cones, bark, twigs, etc., of several plants (mostly trees) were collected from areas known to overlie economic deposits (positive areas), and from areas proved devoid of mineralisation (negative areas); the metal contents of the ash of each sample were determined. The following table summarises the results by showing the average values of about six to eight of the common trees at positive and negative areas in each district.

Mining Camp.	Copper. (*p.p.m.*)		Zinc. (*p.p.m.*)	
	Positive area.	Negative area.	Positive area.	Negative area.
Britannia	13,080	560		740
Chapman Camp		250	4,570	1,560
Texada Island	1,700	350		870
Copper Mountain		290		1,700
Beaverdell		300	2,130	770

From these results the investigators suggest the following tentative working hypotheses. In general plants carry a little more than twice as much zinc as they do copper, and on an average they carry an ash content of from 700 to 900 p.p.m. of zinc. Any reversal in this "normal" relationship may indicate copper or zinc mineralisation. Furthermore, if the ash of plants from any area contains more than twice the "normal" amount of zinc—say more than 1,500 p.p.m.—then that area must, in the light of the evidence at present available, be considered as one of possible zinc concentration.

T. D.

New Mining Legislation for Jamaica.—Until recently, there were virtually no mining laws in Jamaica nor was there statutory provision as to the ownership of minerals. In so far as gold and silver were concerned, it might have been inferred that the English rule that they belonged to the Crown by Royal Prerogative applied to Jamaica, as in other settled Colonies. With regard to other minerals, *prima facie* the owner of the surface was presumed to be their owner. The sole legal provision with regard to these other minerals was contained in a Proclamation of Oliver Cromwell which provided for a tribute from the grantee to the Crown of one-fifth of the value of precious stones and one-tenth of all metals other than gold and silver.

Had the lack of a mining industry in Jamaica continued to obtain so might the simple and yet uncertain nature of the legal provisions for that industry. However, prospecting for bauxite in Jamaica has proved the existence of deposits which mining companies have expressed their desire to work. The official reaction to

this position has been to introduce (*a*) the Minerals (Vesting) Law, 1947; (*b*) the Mining Law, 1947; (*c*) the Mining Regulations, 1947; (*d*) the Radioactive Minerals Law, 1947.

The first of these vests in the Crown all minerals, except mineral oils, gypsum, phosphates, and the usual road-making and building materials. It also prescribes that, where minerals are won from other than Crown land, 5 per cent. of the royalties should be paid to the surface owner up to the fiftieth anniversary of this Law or to the twenty-fifth anniversary of the day upon which, after the commencement of this Law, such minerals were first won, whichever first happens. The reason for this provision is to enable landowners to receive some compensation for mineral assets taken from them by the Crown.

The Mining Law, which does not apply to mineral oil, follows much the usual lines of such bills. For the purpose of this Bill, to which H.E. the Governor gave his assent on September 6, 1947, bauxite and laterite deposits are regarded as alluvial deposits which entails that normally prospecting licences for such areas cannot be held for a period of more than three years in all, as compared with a maximum period of six years in the case of lode deposits. Mining leases are for a period of 25 years, renewable for one further period of 25 years *upon the conditions which may then be generally applicable to new mining leases*. The power to grant the right to prospect or mine gypsum or phosphates is restricted to the owner of the land in question, and a number of the provisions of the Mining Law apply also to these minerals. The Mining Law applies also to the Turks and Caicos Islands.

The Mining Regulations follow much the usual lines, but with one very marked exception, viz. under the special provisions applicable to bauxite or laterite a mining lease for these minerals is not granted to any person other than the owner in fee simple of the land. The only exceptions are where the land in question is Crown land, or where a mining lease has been previously granted to the owner of the land and such lease has been terminated for any reason, or where the Governor in Executive Council is satisfied that the land in question contains bauxite which it is in the public interest should be mined and the owner fails to apply for a mining lease within 12 months of a notice from the Colonial Secretary informing him that it is in the public interest that the bauxite on his land should be mined. A bauxite mining lease may, with the consent of the Governor in Executive Council, be transferred to any person other than the owner of the land.

It is understood that these exceptional provisions are inserted to prevent, as far as may be expedient, the destruction of agricultural land by mining. This is certainly an important consideration in this case since the bauxite occurs as a residual capping on limestone country, much of which is good grazing land. Nevertheless, these provisions are quite novel.

In view of the thinness of the soil layer in the limestone districts coupled with the negligible rate of soil formation on limestone, it is stipulated that before commencing bauxite mining the lessee shall remove the top soil to a depth of not less than 9 in., keep it separate, and on the termination of the lease shall return the top soil to the area from which it has been removed.

The Imperial Institute was consulted in connection with the drafting of this new mining legislation for Jamaica.

A. W. G.

Colonial Mining Law: Radio-Active Minerals.—A number of instances of ordinances and regulations concerning radio-active minerals in various parts of the Colonial Empire have been noted in recent numbers of this BULLETIN (1945, **43**, 322-323; 1946, **44**, 154-155 and 262). In general they restrict the right to search for, mine, dispose of, or export any minerals containing uranium or thorium. They also enforce, under penalty, that any discovery of new occurrences of any of these minerals shall be reported to the officials specified.

Nigeria.—Ordinance No. 37 of 1947 of the Colony and Protectorate of Nigeria, published in the *Nigeria Gazette* of September 11, 1947, pp. 959-968, is the first of the radio-active mineral ordinances of the Colonial Empire to go further than this. It is, in fact, modelled on the United Kingdom Atomic Energy Bill (*see* this BULLETIN, 1947, **45**, 79) and empowers the Governor to do any necessary prospecting, mining or other work in search of radio-active minerals. Where the land in question is already the subject of a mining lease, a mining right or an exclusive prospecting licence, the Governor may serve upon the lessee or the holder of such right or licence a notice specifying the nature of the work proposed to be done, the extent of the land affected and the time within which objection may be made. In the event of an objection being made it is to be heard by an officer of the Legal or Judicial Department.

The powers conferred upon the Governor for the purpose of ascertaining the presence or otherwise of radio-active minerals include: removal of any work constructed or other thing placed on, over or below the surface; to carry out any work that may be needed to restore the land to its original condition; rights of way over any land.

Where it appears that radio-active minerals are present, the Governor may by order provide for compulsorily vesting in him the exclusive right to work those minerals and any other minerals which it appears to him to be necessary to work with those minerals, and may also provide for compulsorily vesting in him any other ancillary rights which appear to him to be necessary, including those of: withdrawal of support; access to or conveyance of minerals, or ventilation or drainage; use and occupation of surface for the purpose of erecting any necessary buildings and installing necessary

plant ; use and occupation of land forming part of or used in connection with an existing mine or quarry, and to use or acquire any plant used in connection with any such mine or quarry ; obtaining and disposal of water. No order under this section can take effect until it has been passed by the Legislative Council.

Provision is made for compensation in respect of loss suffered as the result of the acquisition or exercise of rights in such cases, but no account will be taken, in calculating the compensation payable, of the value of the radio-active minerals.

The Governor may compulsorily acquire any minerals other than minerals in a natural state or contained in a deposit of waste material obtained from any underground or surface working ; also any plant designed or adapted for the production or use of atomic energy or research into matters connected therewith. In addition to police officers, power of examination without warrant is granted to principal officers of the Mines and Geological Survey Departments.

Palestine.—Ordinance No. 48 of 1947, published in the *Palestine Gazette*, September 20, 1947, pp. 291-294, like the Nigerian Ordinance is also based on the United Kingdom Atomic Energy Bill, but with the notable exception that all the compulsory powers noted above under Nigeria are omitted in the case of the Mandated Territory of Palestine.

Gold Coast.—A bill to amend the Radio-Active Minerals Ordinance, 1946, published in the *Gold Coast Gazette*, No. 60, August 23, 1947, pp. 529-530, provides that where any radio-active mineral is discovered in the course of prospecting, etc., such discovery shall be immediately notified to the Chief Inspector of Mines and the Director of Geological Survey, and that no radio-active mineral shall be removed without the consent of the Chief Inspector of Mines.

As a general comment on the foregoing, the extraordinary lack of uniformity in the method of dealing with radio-active minerals in different parts of the Empire will be noted. Moreover, the restrictions on the search for these minerals would seem to be in some conflict with the present-day need to locate them.

A. W. G.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

REPORTS ON FUEL ECONOMY SINCE 1939: Argentine National Committee, pp. 6, $9\frac{1}{2} \times 6\frac{1}{4}$, price *6d.*; Czechoslovak National Committee, pp. 3, $9\frac{1}{2} \times 6\frac{1}{4}$, price *4d.*; Australian National Committee, pp. 10, $9\frac{1}{2} \times 6\frac{1}{4}$, price *6d.*; Report for Germany, prepared under the auspices of the Allied Control Commission for Germany (B.E.), pp. 8, $9\frac{1}{2} \times 6\frac{1}{4}$, price *6d.*; Report for Austria, prepared by the Austrian Ministry of Trade and Reconstruction, pp. 4, $9\frac{1}{2} \times 6\frac{1}{4}$, price *4d.* (London: Central Office of the World Power Conference, 1947.)

Seven reports in this series on the production and consumption of fuel and power in various countries during the period 1939-45 have already been reviewed in this BULLETIN (1947, **45**, 82-83 and 191-192). Those under review cover five countries with widely different requirements for fuel and power.

Statistics given in the report of the Argentine National Committee show that, although about 30 per cent. more fuel and power was consumed in the Argentine Republic in 1945 than in 1939, the proportion of imported fuel in this aggregate consumption dropped from 40 to 6 per cent. within the same years. This was achieved by increasing the domestic production of crude petroleum, wood and charcoal; by mining asphaltite and coal, which were not worked at all in 1939; by the regrettable procedure of burning grain; and by rationing consumption of fuels and power.

Complete statistics had not been established in time for publication in the Czechoslovak report, which states, however, that the coal-mining districts of Bohemia and Moravia were exploited to such an extent by the Germans that the 1944 output was 50 per cent. higher than the 1937 figure. Exploitation of its power stations and gas works also befell the country.

The Australian report reveals that supplies of both indigenous and imported fuels have been inadequate to meet demand, and that black coal production, the most important domestic source of fuel and power, has been hampered by labour shortages. The office of Commonwealth Coal Commissioner, created in 1941 to control black coal production and distribution, was placed on a permanent basis during 1946. In general, it seems clear that the administrative measures necessary in relation to fuel economy have not been rigorous, and that no major technical problems have arisen.

Over one-half of the report for Germany is allotted to the gas industry, the remainder dealing with the production of coal and electric power. As no mention whatever is made of liquid fuels, despite the extreme importance of Germany's war-time developments in synthetic oil production, this report cannot be regarded

even as an attempt to cover the range of subjects with which the series has been stated to be concerned. Furthermore, it is highly questionable, in the case of a country such as Germany, whether the subjects that are considered can receive adequate treatment in only seven pages of text.

The report for Austria, which displays a similar lack of balance, also appears to have suffered from hasty preparation. The important war-time developments in the petroleum industry are barely touched upon, and the technical side of fuel economy receives next to no consideration.

P. L. R.

FUEL ECONOMY CONFERENCE OF THE WORLD POWER CONFERENCE, THE HAGUE, 1947 : Nuclear Energy for Power Production, by Ward F. Davidson, United States National Committee (Section A 6, Paper No. 1), pp. 11, $9\frac{1}{2} \times 6$; L'Energie Atomique en France, by L. Kowarski, Comité National Français (Section A 6, Paper No. 2), pp. 5, $9\frac{1}{2} \times 6$; The Application of Nuclear Energy to the Generation of Heat and Power, by J. D. Cockcroft, C.B.E., Ph.D., F.R.S., British National Committee (Section A 6, Paper No. 3), pp. 5, $9\frac{1}{2} \times 6$. (London : Central Office of the World Power Conference, 1947.)

These pamphlets are proofs of papers presented at the World Power Conference in September, 1947. Each contains a summary in English and French.

In the first paper, a research engineer of an electric utility company describes the scientific and engineering problems involved in the design of a power plant using atomic energy, and attempts to derive construction and operating costs for such a plant. For the figures deduced, the author claims little more than the results of intelligent guess-work.

The author of the second paper believes that the first important installations in France for the production of atomic power will not be functioning before the period 1960-65, and that there must be no slackening in the development of other sources of power in France and the French Union.

Dr. Cockcroft's paper is an attempt to assess, mainly on the grounds of the mathematical side of nuclear physics, the possibility of nuclear energy making a large-scale contribution to world power resources.

P. L. R.

MINE ECONOMICS. Sampling—Valuation—Organisation—Administration. By S. J. Truscott. Second Edition. Pp. vii + 366, $8\frac{1}{2} \times 5\frac{1}{2}$. (London : Mining Publications, Ltd., 1947.) Price 35s.

The first edition of this work appeared in 1937 and was reviewed in this BULLETIN (1937, **35**, 281). The present edition has been revised and expanded here and there, with the inclusion of references to some of the more important recent papers, and the addition of

a new chapter on mine and income taxation that reviews the various practices in force in the United States, Canada, South Africa, Australia and Great Britain. Useful commentaries have also been added to the examples of mining companies' annual financial statements which form an appendix. No attempt has been made to bring up to date the examples of costs which are quoted, but as such changes would doubtless have been of only temporary value, this does not detract from the main purpose of the book. Unfortunately the publishers have not dismissed rising costs so lightly, and the volume is rather expensive.

T. D.

THE LAW OF SUPPORT IN RELATION TO MINERALS. By F. A. Enever, M.C., M.A., LL.D. Pp. xiv + 162, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: The Solicitors' Law Stationery Society, Limited, 1947.) Price 25*s*.

Most people connected with mining in Great Britain will have at least gathered that our law of support in relation to minerals is difficult. Many others who had no wish to be involved either in mining or the law of support have unwillingly become so when their property has been let down or threatened with subsidence consequent upon mining. Nevertheless it is probably true to say that comparatively few even of those who have been involved in questions of support will fully realise the complexity and unsatisfactory nature of the legal position until they have studied this book.

Dr. Enever, a Principal Assistant Solicitor in the Treasury Solicitor's Department, and a member of the Imperial Institute's Mining Law Technical Committee, has held official posts with the Coal Commission and the National Coal Board, and is thus particularly fitted to write the present work, for questions of support in Britain are mostly associated with coal, not only because coal production preponderates so greatly over that of other minerals but because the widely employed longwall methods are particularly prone to let down the surface.

The first 67 pages of the book are devoted to a review of the case law, and the second part, a further 70 pages, to the statute law. The concluding section of 15 pages, whilst recapitulating some of the subject matter, attempts also to set out the legislative changes that appear to be necessary. Indeed the layman is likely to find this the most interesting section and is accordingly recommended to read it first.

Quite apart from those professionally concerned with the subject, there must be many who will find more than passing interest in the story unfolded by this book. How the surface and the mineral rights of many properties became severed in the course of time and the serious complications that often ensued. Case law has shown a growing solicitude on the part of the courts for the interests of the surface owner in the matter of support and

there has grown up a rule of construction that instruments effecting a severance of surface and mineral interests are presumed to preserve to the surface owner a right of support unless by express words or necessary implication a contrary intention is shown. As a result, conveyancers acting for mineral interests have insisted on unambiguous provisions, in some cases so drastic as to leave surface owners without any remedy for damage to buildings. Legislation, however, has proceeded on a different footing, for under the mining codes the mineral owner may let down the surface without liability for damage if he has given notice of approach and no counter-notice has been given requiring the mineral to be left unworked.

The Coal (Registration of Ownership) Act, 1937, and the Coal Act, 1938, provided the machinery for the unification of coal royalties, and the Coal Industry Nationalisation Act, 1946, nationalised the industry itself. As a result, former private interests in coal and certain associated minerals have disappeared, with the single exception of certain ex-copyhold interests. The Coal Act, 1938, left existing rights in relation to support undisturbed, but where the Act itself effected a severance of surface and coal interests new rights were created enabling the mineral owner to withdraw support in working the minerals subject to the obligation to pay compensation for or to make good the damage. The nationalisation of the coal industry has brought to the forefront many of the problems associated with support, and it is in the interests of both the National Coal Board and the surface owners that some workable arrangement should now be devised.

In the section on case law there are a few brief references to china-clay, to salt, and to water disputes, but otherwise the dominance of coal, stated or implied, in the subject matter is almost complete. One might have expected to find some reference to iron ore, which on a tonnage basis is our second largest mineral production, but perhaps the strong nature of the limestone in which the haematite bodies occur, and, apart from the Cleveland Hills, the dominance of opencast methods in the working of bedded iron ore, tend greatly to reduce cases of support in relation to iron ore.

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BULLETIN OF THE IMPERIAL INSTITUTE

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PLANT AND ANIMAL PRODUCTS

CONSULTATIVE COMMITTEE ON HIDES, SKINS AND TANNING MATERIALS

TRIALS TO DETERMINE THE VALUE OF CERTAIN NEW INSECTICIDES AS PREVENTIVES AGAINST HIDE BEETLE

By J. R. Furlong, Ph.D., A.R.I.C.
Secretary to the Committee

It has been the practice in the past to treat hides and skins with an arsenical solution or to add naphthalene to the bales before shipment in order to prevent attack by the hide beetle (*Dermestes vulpinus*). Neither of these methods is fully satisfactory, the use of naphthalene affording only partial protection, while the application of arsenic is subject to several objections, chiefly the necessity of dipping the hides in aqueous solutions with the attendant need to re-dry, and the poisonous character of the solutions to human beings and animals. Improved methods of treatment would be of considerable value to the exporting Colonies in preventing the damage to hides and skins caused by the hide beetle, and the financial loss thereby occasioned. Trials were therefore inaugurated with the object of investigating the possibilities of using the new insecticides, (1) DDT, (2) Gammexane, and (3) Sodium silicofluoride, which, it was hoped, might be more efficient and capable of application by more satisfactory methods than those employed previously in using arsenic compounds.

The scheme for the trials now under report, and comprising the first or preliminary series in this investigation, was drawn up by the writer, who acknowledges the information supplied by Dr. T. F. West, of Messrs. Stafford Allen & Sons, and Dr. R. C. Woodward, of the Imperial Chemical Industries, Ltd., with reference to commercial preparations of the insecticides.

With the approval of the Chairman, the late Dr. Dorothy Jordan Lloyd, and of the Committee, the scheme was submitted to the Secretary of State for the Colonies, with the recommendation that the first part of the trials, in which the skins are treated with insecticide and infested with beetle, should be conducted in Uganda, under the control of the Director of Veterinary Services. Official sanction was accorded. Uganda was chosen as a suitable place for the experiments from the fact that Mr. C. B. Symes, Colonial Office Entomologist, was, at that time, conducting insecticide trials in Uganda in connection with tsetse fly and mosquito eradication, and it was considered desirable that an entomologist with field experience in insecticides should, if possible, be available to advise in the conduct of the trials. Most grateful acknowledgement is made of the co-operation of Mr. Symes, and of Mr. J. B. Randall, Veterinary Officer, in charge of the Livestock Experimental Station, Entebbe, who collaborated in carrying out the experiments.

General Outline of Trials

The insecticides were applied in various forms to goat skins in the country of origin at the stage when the skins had been dried, and would, normally, be ready for export. The treated skins were then subjected to attack by larvae and adults of the hide beetle (*Dermestes vulpinus*) for suitable periods. On completion of the attack the skins were shipped to England, where they were examined in detail on arrival, and then subjected to tanning trials, in which special attention was paid to the presence of insect damage and to the behaviour of the skins during the various tannery operations, with reference to the possible effect of the insecticides on the process, or on the appearance and quality of the resultant leather.

The tanning and finishing of the skins were carried out at the works of the British Chrome Tanning Co., and acknowledgement is made of the assistance afforded by Mr. W. P. Cross and his staff.

Methods

It was required that the skins employed should be of even quality throughout the trials, well prepared but not washed, and suspension-dried in the sun ; of uniform size and weight, 110 lb. per 100 skins, and free from insect attack. Goat skins were chosen in preference to cattle hides on account of easier handling and shorter period of processing. Owing to various local causes skins of the desired standard were not employed for all the trials. For each trial 20 skins were employed.

The insecticide was applied only to the hair side of the skin, and the skins were then piled, the flesh side of one skin being in contact with the hair side of the skin below it in the pile. Dusts were applied by blower or by hand, and solutions or suspensions by sprayers. The skins receiving a water preparation of insecticide were redried before they were piled. The piles were made in wooden

containers with lids in order to isolate each trial. Larvae and beetles of *Dermestes vulpinus* were added between the skins and close contact of the skins was secured by suitable pressure. The insect attack was allowed to continue until the control batch of skins showed considerable insect damage. The insects were then removed, the number of living insects recovered being recorded, together with other details of the trials.

I. Trials with DDT
(Dichlor-diphenyl-trichlorethane)

(*a*) *Treatment of skins with insecticide, and infestation.*

The following record was furnished by Mr. J. B. Randall:

Dusts

Diatomite containing 5 per cent. DDT.
Trial 1. ½ lb. dust per 20 skins.
Trial 2. 2 lb. dust per 20 skins.

Solution in Organic Solvent

5 per cent. DDT. 20 per cent. cotton seed oil in kerosene.
Trial 3. ½ pint per 20 skins.
Trial 4. 2 pints per 20 skins.

Water Emulsion

T.P.520; diluting 1 vol. with 7 vols. of water to give a strength of 3 per cent. DDT.
Trial 5. 1 pint per 20 skins.
Trial 6. 3 pints per 20 skins.

Control

Trial 19. Untreated.

Immediately following treatment with insecticide on June 22, 1946, each batch of 20 skins was inoculated with 285 larvae and 95 adult *Dermestes vulpinus* (i.e. 15 larvae and 5 adults between skins).

On August 17, 1946, the skins were examined and the following brief notes made:

Trial 1. New damage considerable; 40 living larvae including new hatch and 15 adults observed; fairly considerable mould growth.
Trial 2. New damage noted; 6 living larvae and 1 adult observed. Mould growth considerable.
Trial 3. No living larvae or adults observed. Mould growth around the edges of skins; a few skins showing mould over surface.
Trial 4. No living larvae or adults observed. Mould growth around edges of skins.
Trial 5. One living adult noted. Fairly considerable mould growth.
Trial 6. One living larva noted. Considerable mould growth.

Trial 19. Larvae and adults numerous; damage obvious. Fairly considerable mould growth.

No *Dermestes* were removed at the above examination.

On September 16, 1946, the skins were removed from the containers and examined.

Recoveries of living *Dermestes* were as follows:

Trial 1.	Adults, 25	Larvae, 121
Trial 2.	,, 1	,, 1
Trial 3.	,, 3	,, Nil.
Trial 4.	,, Nil.	,, Nil.
Trial 5.	,, Nil.	,, Nil.
Trial 6.	,, Nil.	,, Nil.
Trial 19.	,, 163	,, 273

Temperature Range for the period, 69·5° F. (min.) to 79° F. (max.).

Relative Humidity—midnight, 100 per cent. over whole period.
mid-day average, 73 per cent. over whole period.
maximum, 95 per cent. on July 9, 1946.
minimum, 47 per cent. on July 1, 1946.

A few of the skins showed slight insect damage around edges prior to treatment.

(*b*) *Examination of skins on arrival in England*

The consignment was examined, skin by skin, with the following results:

Trial 1. There was slight insect attack on 12 skins, and more pronounced damage on two skins. The attack was chiefly round the edges of the skins, which amounted to perforation in some cases.

Trial 2. There was no noticeable damage by grub attack in the batch of skins from this trial.

Trials 3, 4, 5 and 6. No insect attack was noticeable in these batches of skins.

Trial 19. There had been a very considerable attack by insects in this trial, and the damage was pronounced. All skins had been attacked, a few severely.

The skins were in dry condition and, on the whole, had been nicely taken off; no taint was apparent at this stage. Throughout the seven batches varying amounts of superficial mould were evident.

(*c*) *Tannery report on skins in blue.*

The report made by the tanner on the skins in blue, i.e. after chroming but before finishing, recorded insect damage in accordance with that observed in the raw skins. It also referred to the presence, in each batch, of a few skins showing putrefactive damage (taint), and several skins which showed dark blue stains. The skins in Trials 5 and 6, in which a water emulsion was applied, showed no greater amount of taint than the skins from the other trials.

Note.—Dark stains. The dark blue stains reported by the tanner were investigated, and it was considered that they were attributable to the mould and taint present on the skins. The control skins, which received no insecticide, showed this feature, and it was evident that the stains had no connection with the application of the insecticide.

(*d*) *Examination of the finished leather.*

The skins, which had been tanned and finished as glacé kid leather, were examined skin by skin.

Trial 1. Five skins showed a few marks of very slight insect damage on the flesh side.

Trial 2. Two skins showed a few marks of very slight insect damage.

Trials 3, 4, 5 and 6. These skins showed no sign of insect attack.

Trial 19. Five skins showed slight insect damage on flesh and grain, mostly seen on the former.

A few skins in each batch showed putrefactive damage, those which had received a water emulsion exhibiting no more taint than other skins. In most lots disease-marked skins were present.

The damage due to insect attack which could be seen in the finished leather was generally very slight, except in the case of the untreated control skins of Trial 19, where the damage was more apparent. The difference between the controls and the other skins was, however, sufficiently pronounced to show the beneficial effect of applying the insecticide.

(*e*) *Report on the behaviour of the skins during the tannery operations.*

There were no signs at any period of working the skins in the tannery, from handling the raw skins to the inspection of the finished leather, of interference by the added insecticides with the normal processes. The insecticide present on the skins had no effect on the workers or the working operations.

II. Trials with Gammexane and Sodium Silicofluoride

(*a*) *Treatment of skins with insecticide, and infestation.*

Gammexane

The materials employed were products made by the Imperial Chemical Industries, Ltd., consisting of preparations of benzene hexachloride, the gamma isomer of which, known as Gammexane and constituting 13 per cent. of the crude mixed isomers forming crude benzene hexachloride, is the active constituent.

The following record was furnished by Mr. J. B. Randall:

Dust

Diatomite containing 4 per cent. of Gammexane Dust Concentrate (D.929), which is crude benzene hexachloride, containing 13 per cent. of the gamma isomer.

Trial 7. ½ lb. dusted on 20 skins.
Trial 8. 2 lb. dusted on 20 skins.

Solution in Organic Solvent

Gammexane Liquid Concentrate (L.G.037) containing 7 per cent. of the gamma isomer.

Trial 9. 1 vol. of L.G.037 with 49 vols. of mineral turpentine (Shell). 3 pints to 20 skins.

Trial 10. 1 vol. of L.G.037 with 14 vols. of mineral turpentine. 3 pints to 20 skins.

Water Emulsion

Gammexane Miscible Oil (M.G.035), containing 5 per cent. of the gamma isomer.

Trial 11. 1 vol. M.G.035 with 3 vols. of water. 3 pints to 20 skins.

Water Dispersion

Gammexane Dispersible Powder (P.530), containing 50 per cent. of crude benzene hexachloride or 6·5 per cent of the gamma isomer.

Trial 13. 1 part of P.530 with 24 of water. 3 pints to 20 skins.

Trial 14. 1 part of P.530 with 15 of water. 3 pints to 20 skins.

Control

Trial 18. No treatment.

Sodium Silicofluoride

Dust

Diatomite containing 4 per cent. of finely divided sodium silicofluoride.

Trial 15. ½ lb. dusted on 20 skins.

Trial 16. 2 lb. dusted on 20 skins.

Diatomite containing 25 per cent. of finely divided sodium silicofluoride.

Trial 17. 1 lb. dusted on 20 skins.

Following the treatment with insecticide (Gammexane formulations on September 20, 1946 ; Sodium silicofluoride on October 11 1946) each batch of 20 skins was inoculated with 285 larvae and 95 adults of *Dermestes vulpinus* (i.e. 15 larvae and 5 adults between skins). The batches of skins were placed in the wooden containers and struts inserted to keep the skins in close contact.

The control box contained 20 untreated skins, with a similar infestation of *Dermestes*

Many of the skins bore evidence of appreciable damage by *Dermestes*, especially round the edges, before the trials were carried out ; most of the damaged areas were marked with blue grease pencil. In the case of the Gammexane series all formulations gave 100 per cent. kill, and all the observable insect damage can be regarded as having occurred before the trials were made.

The Gammexane series were inspected on November 25, 1946, and the following observations recorded. The references are to live insects.

Trial 7. No beetles or larvae observed.
No mould growth.

Trial 8. No beetles or larvae observed.
No mould growth.

Trial 9. No beetles or larvae.
No mould growth ; skins in perfect condition.

Trial 10. No beetles or larvae.
No mould growth ; skins in perfect condition.

Trial 11. No beetles or larvae.
Considerable mould growth on all skins.
Trial 13. No beetles or larvae.
Considerable mould growth on all skins.
Trial 14. No beetles or larvae.
Considerable mould growth on all skins.

The Sodium silicofluoride series were examined on December 14, and the following observations recorded:

Trial 15. Extensive new damage.
Numerous larvae and beetles observed.
No mould growth.
Trial 16. New damage noted.
A few larvae and beetles observed.
No mould growth.
Trial 17. New damage slight.
A few larvae and beetles observed.
Trial 18. Control; no treatment.
Extensive damage on all skins.
Beetles and larvae very numerous throughout the batch.

No *Dermestes* were removed at the above examinations.

On December 27, 1946, the skins were removed from the containers and examined.

Recoveries of living *Dermestes* were as follows:

Trials 7 *to* 14.	Adults,	Nil.	Larvae,	Nil.
Trial 15.	,,	51	,,	172
Trial 16.	,,	20	,,	27
Trial 17.	,,	2	,,	5
Trial 18 (Control).	,,	207	,,	411

Temperature Range, maximum 80·5° F., minimum 55° F.

Mid-day Average Humidity, 70 per cent.
Midnight Average Humidity, 100 per cent.

(*b*) *Examination of skins on arrival in England.*

The consignment was examined, skin by skin, with the following results:

Trials 7 to 11, 13 *and* 14 *inclusive* (*Gammexane*): 140 skins. All the skins, with only two exceptions, had been attacked by insects; the damage ranging from slight to severe. On 126 skins the areas attacked had been ringed with blue, denoting attack prior to commencement of trials. On 12 skins the attacked areas were not marked in blue; these skins were in trials 7, 8 and 14, they represent a very small proportion of the total number of skins, and in general the amount of insect damage in all the batches was similar.

In trials 11, 13 and 14 a few skins showed slight superficial mould.

The skins in Trial 11, where a large amount of Gammexane had been applied, had a slight and unpleasant

odour, which was also noticeable to a lesser extent in other trials.

Trials 15 *to* 17 *inclusive* (*Sodium silicofluoride*): 60 skins. There was only one skin free from insect damage. On seven skins the attacked areas were ringed with blue; 52 skins showed insect damage which had not been marked with blue, indicating attack during the trials. The damage varied in the skins from mild to severe, and was approximately equal in the three batches.

Trial 18. *Control.* All the skins were very badly attacked. The damage was very markedly more severe than in the batches of treated skins, and had occurred during the trials.

The consignment was in good, dry order, and no putrefaction was apparent. The skins had been well taken off; they had been cleaned for the removal of fat in most cases, but some showed small amounts.

(*c*) *Tannery report on skins in blue.*

The tanner's report on the skins after chroming and before finishing confirmed the general insect attack noted in the raw skins, but at this stage ringed and unringed damage could not be recorded as the blue markings had now been removed.

Putrefaction, slight or pronounced, was reported on a small number of skins throughout the consignment, but not correlated with any particular treatment.

(*d*) *Examination of the Finished Leather.*

The skins, which had been tanned and finished as glacé kid leather, were examined skin by skin.

Damage due to insect attack was in evidence on the grain throughout all the batches, varying from very slight blemishes to pronounced faults. The amount and distribution was in accordance with that recorded in the examination of the raw skins. It was not possible to differentiate in the finished leather between ringed and unringed areas of attack, which renders a detailed record of damage of no significance.

(*e*) *Report on the Behaviour of the Skins during the Tannery Operations.*

The insecticides employed had no influence on any of the tannery operations, and no effect on the quality of the finished leather.

There was no discomfort in handling the treated skins in the raw or during the working operations. No objection was raised to the slight odour of the skins which had received Gammexane.

Summary

(i) *Results of Treatment and Infestation*

After treatment of the skins with insecticide 95 adults and 285 larvae of *Dermestes vulpinus* were added in each trial.

Trial.	Application.	Quantity of Insecticide per 100 sq. feet of skin.	Recoveries of *Dermestes* (live) after 3 months. Adults.	Larvæ
1	Dust	13 gms. of DDT	25	121
2	,,	50 ,, ,, ,,	1	1
3	In organic solvent	16 ,, ,, ,,	3	0
4	,, ,, ,,	63 ,, ,, ,,	0	0
5	Water emulsion	19 ,, ,, ,,	0	0
6	,, ,,	57 ,, ,, ,,	0	0
19	Control	Untreated	163	273
7	Dust	1·3 gms. of Gammexane*	0	0
8	,,	5·2 ,, ,, ,,	0	0
9	In organic solvent	2·7 ,, ,, ,,	0	0
10	,, ,, ,,	9·0 ,, ,, ,,	0	0
11	Water emulsion	23·7 ,, ,, ,,	0	0
13	,, dispersion	5·0 ,, ,, ,,	0	0
14	,, ,,	7·7 ,, ,, ,,	0	0
15	Dust	10 gms. of Sodium silicofluoride	51	172
16	,,	40 ,, ,, ,, ,,	20	27
17	,,	126 ,, ,, ,, ,,	2	5
18	Control	Untreated	207	411

* *Calculated as Gammexane, the gamma isomer of benzene hexachloride.*

The quantities of insecticide per 100 sq. ft. of skin, given in the above table, must be regarded as approximate, since the figure for the area of the skin is an assumption based on the usual run of skins of the 100/110 lb. class. The size of a skin has been taken as roughly 4½ sq. ft., the insecticide being applied on one side only of the skin. It has also been assumed that no loss of dust or spray occurred in the application of the insecticide, whereas some loss was unavoidable.

In Trials Nos. 1 to 6, in which the insecticide employed was DDT, the results show that an application of 13 gms. of the insecticide in dust form per 100 sq. ft. of skin was not sufficient to kill all the added insects, though effecting considerable control of the infestation, while a dose of 50 gms. was practically efficient, when compared with the result on the untreated control skins in Trial No. 19. The application of the insecticide in solution in an organic solvent or as a water emulsion was more effective than as a dust, and it would appear that the minimum effective dose in organic solvent is at the level of 16 gms. per 100 sq. ft. of skins; the insecticide as a water emulsion was 100 per cent. effective at the rate of 19 gms.

All the applications of Gammexane were 100 per cent. effective, including the smallest dose of 1·3 gms. per 100 sq. ft. of skin, and consequently the minimum amount for successful protection of the skins was not determined. The amounts of Gammexane applied were understood at the time the trials were set out to be around the probable optimum dose, but subsequently the insecticide was found to be more efficient, and this is confirmed by the present results.

Trials Nos. 15 to 17, in which Sodium silicofluoride was applied, show that treatment at the rate of 126 gms. (=4½ oz.) per 100 sq. ft. of skin was practically effective, while smaller applications only partially reduced the attack as compared with the untreated skins in Trial No. 18.

(ii) *Results of Tanning Trials*

In the Trials Nos. 1 to 6 in which DDT was applied, although the count of recovered *Dermestes* showed the amount of insecticide applied in Trial No. 1 had been insufficient to destroy all the added insects, the amount of damage done to the skins as seen in the finished leather was very slight. Since a fair number of insects survived the treatment period of three months, further damage might have occurred if the attack had been allowed to continue. In the remaining Trials, Nos. 2 to 6, apart from traces of damage in the skins of Trial No. 2, all the finished leather was free from insect damage.

In Trials Nos. 7 to 14, in which Gammexane was the applied insecticide, and in Trials Nos. 15 to 17, in which Sodium silicofluoride was used, judgment of the results, so far as effective insect control was concerned, by inspection of the skins during their working in the tannery, was rendered impossible owing to the fact that skins had been employed for these trials which had suffered considerable insect attack before treatment with insecticide. An attempt had been made to mark pre-treatment damage with blue pencil, but the differentiations between this and subsequent attack could only be made while the skins were in the raw state, and not after the initial treatment in the tannery or in the finished leather, when the blue markings had been eliminated. The inspection of the raw skins disclosed presence or absence of insect attack in line with the results of the insect recovery counts.

The tanning trials clearly showed that none of the three insecticides, or the materials associated with them, used in these trials interfered in any way with the tannery operations involved in producing chrome-tanned glacé kid leather. There was no discomfort in handling or working the treated skins concerned.

To sum up, these trials, which were intended to be of a preliminary nature, have shown that DDT, Gammexane and Sodium silicofluoride are all capable of protecting skins against *Dermestes* attack when applied in suitable quantity, and their use does

not affect the handling or subsequent chrome tannage of the skins.

It is intended to continue the investigation in order to determine the most suitable form of application under varying local conditions. The results of the present trials have shown how effective control of *Dermestes* attack is possible by the use of dusts containing DDT, Gammexane or Sodium silicofluoride, on the lines of Trials Nos. 2, 7 and 17.

In future experiments attention will be paid to the use of water emulsions and dispersions, since there is evidence in the present results of the greater efficiency of such applications over the employment of the insecticide in dust form. At the same time the rewetting of hides and skins carried with it the latent danger that the required re-drying may not be properly carried out, and give rise to putrefaction, which is a shortcoming encountered in the use of arsenical dips, and one which it is sought to eliminate by a new procedure. In the present trials the re-drying of the wetted skins was satisfactory and no taint due to this operation was observed. The application of the insecticide in an organic solvent would overcome this danger, but at present it would appear to be too costly.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion and Colonial Governments

MANILA HEMP FROM MALAYA AND DOMINICA

By N. S. Corney, B.Sc., A.R.I.C., J. R. Furlong, Ph.D., A.R.I.C., and R. H. Kirby, B.Com.

The annual amount of Manila hemp required by the United Kingdom for use chiefly in marine cordage is about 30,000 tons. The main source of this fibre is the Philippine Islands. Unfortunately none is produced on a commercial scale within the British Empire. Cultivation trials of the plant yielding Manila hemp (*Musa textilis*) have, however, been made from time to time in some of the Empire countries, such as St. Vincent, Malaya and British North Borneo. The most promising results have been obtained in the last-named country, but the plantations there have of recent years suffered from a disease allied to "bunchy-top." If attempts to eradicate this disease are successful it is believed there should be considerable possibilities for the commercial production of Manila hemp in that island.

Malaya

In Malaya Manila hemp has been cultivated so far only under experimental conditions by the Department of Agriculture and on a few European-managed estates. In general, the Malayan climate has proved to be suitable. Further information on the cultivation of this plant in Malaya is published in the *Malayan Agricultural Journal* (1947, **XXX**, No. 3, pp. 123-129).

The following varieties of *M. textilis* have been established in Malaya. These were introduced from the Philippine Islands:

(i) Var. *Tangongon*. A tall, hardy variety growing to a fair size, even when conditions are not as favourable as desired. In trials made at the Central Experiment Station, Serdang, the yield of fibre was from 1·9-2·0 per cent.

(ii) Var. *Bangulanon*. This variety is not as hardy as *Tangongon*, but it gave a higher yield of fibre, namely, 2·25-2·3 per cent.

(iii) Var. *Baguisanon*. The yield of fibre was only 1·0-1·5 per cent. This variety was not very successful at Serdang.

A sample of fibre from each of these three varieties grown at the Central Experiment Station, Serdang, were received in 1946 from the Department of Agriculture at the Imperial Institute, where they were examined and their quality reported upon by commercial firms.

The samples were, on the whole, well cleaned except for a small amount of dark fibre and unseparated strands. The colour was

generally good and lustrous, being light to dark cream with a small amount of brownish, harsh fibre. The strength on the whole was very good, with little difference between the three samples.

Length of fibres: Bangulanon, 7 to 8½ ft.; Baguisanon, 6 to 8½ ft.; Tangongon, 6 to 8½ ft. with a small amount 5 ft. In preparation and appearance Bangulanon was the best, while Baguisanon was not quite so well cleaned, and in this respect Tangongon was not quite so good as Baguisanon.

On the whole the three samples were of very good appearance, strength and length.

Results of Examination

The sample of best prepared fibre, Bangulanon, was submitted to chemical examination. The results are shown below in comparison with three grades of commercial Manila hemp (from Philippines) previously examined at the Imperial Institute:

	Present Sample	Commercial Samples of Manila Hemp examined at the Imperial Institute.		
	Variety Bangulanon.	F.	G.	L1
	per cent.	*per cent.*	*per cent.*	*per cent.*
Moisture	9·8	10·7	10·6	8·9
Calculated on the moisture-free fibre:				
Ash	0·7	1·5	1·9	3·2
α—Hydrolysis (1 per cent. Na_2O solution for 5 minutes)	11·5	13·4	12·3	12·9
β—Hydrolysis (1 per cent. Na_2O solution for 60 minutes)	17·6	20·2	19·2	19·3
Water washing loss	1·2	2·4	3·5	5·3
Cellulose	78·4	76·9	74·5	74·8

The ultimate fibres of this sample were found to have the following dimensions, which are shown in comparison with the recorded dimensions for commercial Manila hemp (*Musa textilis*):

	Length in mm. Maximum.	Minimum.	Average.	Diameter in mm. Maximum.	Minimum.	Average.
Present Sample	6·5	3·4	4·6	0·025	0·01	0·017
Commercial Manila Hemp	12·0	3·0	6·0	0·032	0·016	0·024

The chemical examination shows the Malaya-grown Manila hemp (Bangulanon variety) to have a low ash content and a high cellulose content, and to suffer low hydrolysis losses in comparison with the three grades of commercial Manila hemp quoted above. These results are very satisfactory. The dimensions of the ultimate fibres show slight variations from the recorded figures, but these variations are of no material significance.

Commercial Valuation

The samples were submitted to two firms of fibre merchants,

whose representatives are members of the Imperial Institute Consultative Committee on Vegetable Fibres. Their reports are as follows:

I

" **Bangulanon**

Good length, fine, soft, well-cleaned fibre, good sheen, strength excellent.

Value £145 per ton c.i.f. U.K. (February, 1947).

Baguisanon

Good length, nice bright fibre, good sheen, strong. Somewhat harsher than the previous mark, containing strips of undecorticated fibre; good colour.

Value £135 per ton c.i.f.

With a little more careful cleaning this could easily be equal to Bangulanon.

Tangongon

Good length; colour slightly lower than the Bangulanon; strength good; a great number of the fibres poorly cleaned; too much strippy fibre.

Value £130 per ton c.i.f.

Greater care should be taken with the cleaning although all three samples would to-day find an excellent market owing to the world shortage of fibres.

The samples compare very favourably with the Manila hemp produced in the Philippine Islands and certainly much better than the fibre produced in Central America.

I would like to point out, however, that to-day's (February, 1947) prices are very much inflated owing to the world shortage of all hard fibres, and it would not be safe to count on getting these prices in 1948 and 1949. The pre-war values were about £26 per ton c.i.f., and the span between the different qualities would naturally be much less than on to-day's values.

Undoubtedly there would be a very good market for this class of fibre and it would compete favourably with any fibre produced in other parts of the world."

II

" **Bangulanon**

Length. 7 to 8 ft.

Cleaning. Mostly excellent and good, a proportion of fair.

Strength. Good to fair, with a proportion of weak fibre.

Colour. As Baguisanon.

General. Soft, excellent spinning quality varying from Davao 'E' to Davao 'J2' equivalent, averaging Davao 'I' and Davao 'S2.' On the whole this is the best of the three samples.

Baguisanon

Length. 6 to 8 ft.

Cleaning. Mostly excellent and good, with proportion of fair and coarse. With improved preparation would be excellent and good.

Strength. Mostly very good.

Colour. Varying between light and dark cream with a proportion of streaky.

General. Soft, good spinning quality varying from Davao 'F' to Davao 'G' equivalent, but containing a small proportion of lower grades and rejections. Average between Davao 'I' and Davao 'S2' equivalent.

Tangongon

Length. 6 to 8 ft.

Cleaning. Mixed. Varying between excellent and coarse, with some defects which should go into rejections. With more careful preparation should average between excellent and good.

Strength. Satisfactory.

Colour. Varying between very light cream and ochre with some streaky and discoloured.

General. Fibre is mixed, varying from Davao 'F' down to Davao 'L1' equivalent, but containing a considerable proportion of rejections. Given more careful preparation and classification, fibre should average at least Davao 'J1' equivalent.

Summary.

Hemp of this quality would be readily saleable. Present values:

Bangulanon £130 }
Baguisanon £125 } per ton c.i.f. Europe (February, 1947).
Tangongon £120 }

In comparison with J2 Manila at £95, present value, which stood at an average of £23 over 5 years pre-war."

Conclusions

All three samples are of very good quality and differ but slightly in appearance and strength. They compare favourably with the commercial Manila grades which have been quoted above. The sample of Bangulanon variety was the best of the three present samples, and was valued at £130 to £145 per ton. All the samples would be readily saleable and the prices given in the valuations are exceptionally high. They represent the current values, but it is not possible to say how long the market will continue at this level.

In 1947 four further samples o Manila hemp were received at the Imperial Institute from the Department of Agriculture, Malaya. These had been prepared at the Coconut Experiment

Station, Port Swettenham. Three of the samples were derived from the varieties grown at Serdang (see p. 336); the fourth was a local variety.

It is of great interest to note that the soil at Port Swettenham on which the Manila plant was successfully grown was a very stiff, heavy clay. The soils of the Philippines and of North Borneo are of volcanic origin, and there had been a tendency to connect this type of soil with successful Manila production.

Descriptions

1. Variety, Local.

Light cream-coloured fibre with a small amount of brownish-cream fibre; lustrous and bright. Mostly well cleaned, but unseparated strips were present to a small extent. On the whole mostly fine fibre. Strength was generally fair, but some weak fibre present. Length, variable, mostly about 7 ft.

2. Variety, Bangulanon.

Light cream to brownish-cream coloured fibre; fairly lustrous and bright. Major part of sample was fairly well cleaned, but part consisted of unseparated strips, present to a greater extent than in Sample 1 (local variety). Fibre was rather coarse. Generally strong, but some rather weak fibre present. Length, mostly about 6-7 ft.

3. Variety, Tangongon.

Light cream to brownish-cream coloured fibre; a very small amount of brown fibre was present; fairly lustrous and bright. Part of sample was fairly well cleaned, and part consisted of insufficiently separated fibre. Rather coarse fibre. Strong to fairly strong. Length from 6 to 8 ft.

4. Variety, Baguisanon.

Light cream to brownish-cream coloured fibre, with a very small amount of brown fibre, fairly lustrous and bright. On the whole the fibre was fairly well cleaned. Fibre varied from fine to coarse. Strong generally, with some rather weak fibre present. Length, about 7 to 8 ft.

General Comparison with the Samples from Serdang

The sample of "Variety, Local," is rather better in colour, cleanness and preparation than any of the other samples in the present set, or in the previous set from Serdang. It is, on the whole, also finer, but lacks strength in some of the fibre.

The other three samples of the present set are, in general, not so clean as the previous ones from Serdang, by a small margin, and not quite so good as regards strength. The colour of the present set is somewhat superior, and much less reddish-brown fibre was present.

Commercial Valuation

The samples were submitted to two firms of fibre merchants, whose representatives are members of the Imperial Institute Consultative Committee on Vegetable Fibres. Their reports are as follows :

I

" **Local.**

Fine, soft, well-cleaned fibre, very strong, equal to Manila 'F' ; value £125 per ton (July, 1947).

Bangulanon.

Rather mixed colour, very strippy fibre, good length, strong, but fibre should be sorted better ; it is certainly not as good as the previous sample ; could be improved by better classification ; equal to Manila 'S2' ; to-day's value £90 per ton.

Tangongon.

Good length, strong, well-cleaned fibre ; not as good as the 'Local.' Fibre bolder, very strong ; equal to Manila 'I' ; to-day's value £112 per ton.

Baguisanon.

Good length, some poorly stripped fibre ; colour good ; rather harsh ; strong ; equal to Manila low 'I' ; could be improved by better cleaning ; to-day's value £108-£110 per ton.

You will notice that the market values have declined considerably since February 1947, and they were considerably lower in May than they are to-day. We would again state that provided you can produce a quantity of this fibre there would be a very good market for it. We shall be very interested to know what prospects there are of an early production."

II

" **Local.**

Length. Irregular, 5 to 8 ft., mostly 7 to 8 ft.

Cleaning. Mostly excellent to good, some fair. The best of any samples so far.

Strength. Fair but tending decidedly brittle, probably due to immature plants.

Colour. Off white to light cream.

General. Excellent soft and fine spinning quality. Mainly Davao 'F' and 'I' equivalent, some 'S2' and 'G.' (Bulk will probably average nearer Davao 'J1' equivalent.)

Bangulanon.

Length. 6 to 7 ft.

Cleaning. Fair to good with some defective and discoloured.

Strength. Mainly good but tending weak in places.

Colour. Good, mixture of cream and sandy with small proportion of brownish streaky fibre.

General. Harsher than previous sample of the grade. Mixture

of Davao 'S2,' 'G,' 'J2,' 'S3' equivalent. Fibre somewhat badly handled. With more care should average Davao 'G' equivalent.

Tangongon.

Length. 6 to 8 ft.

Cleaning. Very mixed. Varying from good to coarse with a proportion of rejections. Defects due to inadequate stripping.

Strength. Good to fair.

Colour. Very good, varying from very light cream to ochre and streaky.

General. The fibre is mixed, varying from Davao 'I' to Davao 'L1' equivalent with a proportion of rejections. Given better cleaning and classification an average of 'J1' should be obtained.

Baguisanon.

Length. 7 to 8 ft.

Cleaning. Good overhead, some excellent, but traces of defective cleaning.

Strength. Better than Bangulanon but some traces of brittleness.

Colour. Light cream with traces of streaky fibre at crop and tip ends.

General. Softer and finer than the above, equivalent to a mixture of Davao 'I' to 'G.' With better cleaning the average would approach Davao 'F.' (Sample is too small and bulk will probably average Davao 'J1' equivalent.)

Comparing these latest samples with those received last January from the Central Experiment Station at Serdang, the preparation, or more specifically the stripping or cleaning of the fibre, is not as good, and shows a higher proportion of defects. On the other hand, the colour and lustre is quite decidedly better. The strength is about the same, and roughly 'Fair Average' as compared with Philippine Abaca.

The variety marked 'Local' has not been previously sampled so that no comparison is possible, but this is particularly interesting as it shows scarcely any defects and is decidedly superior for this reason to the others and to the first set of samples, apart from strength, in which it is somewhat inferior. Given some care in preparation there should be no difficulty in producing all the varieties to this standard, in which case they would compare well with the best Philippine fibre from Davao Province. As the samples have been produced on a Hagotan machine the employment of fully skilled operators will be all that is necessary to put matters right.

The latest samples have, in fact, confirmed our previous view that an excellent quality of Abaca fibre can be produced in Malaya, and that it should compare favourably with the Philippine production.

We have not give a valuation in our report, but would say these samples are, with their defects, on an average just under Davao 'G' equivalent, and would be worth to-day about £105 per ton c.i.f. (July 1947). If the defects were eliminated the fibre would probably average about Davao 'J1' equivalent, and have a value of about £110 to £115 per ton c.i.f. These values are lower than those which we gave for the Serdang samples because the price of Philippine Abaca has fallen somewhat since the beginning of the year. When fibre is commercially produced it would be advisable for it to be selected into grades.

We shall be most interested to know about any further developments, and we hope that commercial production of Malayan Abaca will soon be begun."

Conclusions

The four samples under report are all of very good quality, and comparable with the normal supplies of hemp from the Philippines. Comparison with commercial Manila grades has been stated above. Defects in preparation, cleaning and sorting are apparent in the samples, which could be eliminated easily, giving a product of enhanced value.

The present samples and those previously reported on from Serdang represent Manila of such satisfactory quality and show promise of reaching a higher standard by improved preparation, that all possible steps to advance quickly to commercial production are strongly recommended.

DOMINICA

In Dominica the Department of Agriculture have trial plots of *M. textilis* in six different areas of the island, some of the stock having been introduced about 1908 and other more recently from Trinidad.

In 1947 two samples of Manila hemp were received at the Imperial Institute. These had been derived from plants found growing in Dominica, which had been introduced around 1908. They were examined at the Imperial Institute and were submitted to commercial firms for their commercial valuation. In each case the fibre had been extracted from three stems growing in the Botanic Gardens, Roseau.

Description

Sample A.

10¼ oz. Manila hemp. Extracted from 3 stems weighing 69 lb.

Sample B.

10 oz. Manila hemp. Extracted from 3 stems weighing 69 lb.

Sample A was well prepared, clean, and of good colour, being cream and bright. The fibres were well separated and there were

no hard runners. Length about 7 feet. The strength was variable but in general fair.

Sample B was similar to Sample A but was not so well cleaned. The general length was about 8 feet. The strength was good.

Results of Examination

The better prepared sample, viz. " A," was submitted to chemical examination. The results are shown in comparison with three grades of commercial Manila hemp previously examined at the Imperial Institute:

	Present Sample A.	Commercial Samples of Manila Hemp examined at the Imperial Institute.		
		F.	G.	L1
	per cent.	*per cent.*	*per cent.*	*per cent.*
Moisture	10·2	10·7	10·6	8·9
Calculated on the moisture-free fibre:				
Ash	1·3	1·5	1·9	3·2
α—Hydrolysis (1 per cent. Na_2O solution for 5 minutes)	16·5	13·4	12·3	12·9
β—Hydrolysis (1 per cent. Na_2O solution for 60 minutes)	22·6	20·2	19·2	19·3
Water washing loss	4·1	2·4	3·5	5·3
Cellulose	73·3	76·9	74·5	74·8

Ultimate fibres were prepared from the samples and examined. They were found to have the following dimensions, which are shown in comparison with the recorded figures for commercial Manila hemp:

	Length in mm.			Diameter in mm.		
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
Present Sample	6·6	3·7	5·2	0·034	0·012	0·020
Commercial Manila Hemp	12·0	3·0	6·0	0·032	0·016	0·024

The present sample has slightly higher α and β hydrolysis losses than the commercial samples of Manila hemp quoted above, and a somewhat lower cellulose content. The ash content is satisfactorily low. The water washing loss is fair. These figures indicate a slight inferiority in composition and durability in comparison with the grades of commercial fibres which have been quoted. The dimensions of the ultimates do not differ materially from the recorded figures for commercial samples of Manila hemp from the Philippines.

Commercial Valuation

The samples were submitted to two firms of fibre merchants, whose representatives are members of the Imperial Institute Consultative Committee on Vegetable Fibres. Their reports are as follows:

I

" **Sample ' A.'**

Length. Average 6 ft.

Cleaning. Good with minor defects.

Texture. Fine.
Strength. Fair but some weakness apparent.
Colour. Light to dark cream with proportion almost white.

Generally, the sample contains a mixture of fibre of quality approximately equivalent to Davao 'I,' Davao 'J1,' Davao 'S2.' and Davao 'G.' The value at current prices would be approximately £115 per ton c.i.f. U.K. (April 1947).

Sample 'B.'

Length. $5\frac{1}{2}$ ft. to 7 ft.
Cleaning. Fair to good but partly defective.
Texture. Tending somewhat coarse and harsh.
Strength. Good.
Colour. Light to medium cream.

Generally, the fibre is a mixture and equivalent in quality to Davao 'J1,' Davao 'G,' Davao 'J2' and Davao 'K.' The value approximately £105 per ton c.i.f. U.K.

Summary.

Such defects as are shown by the samples could be remedied by better preparation and classification, and it should then be similar to Philippine Manila Hemp."

II

"Both samples appear to me to be very good; the one marked 'A' is well cleaned, good length, good colour and strong; to-day's value is about £120 per ton c.i.f. U.K. (April 1947). The sample marked 'B' is rather poorly cleaned containing too much strip; fair length, also some of the fibres show signs of weakness which is probably due to insufficient drying or the possibility that the tuxies were not stripped immediately they were cut. I am of the opinion that this grade could be improved with better care and cleaning; to-day's value is about £100 per ton c.i.f. U.K."

Conclusions

The present samples are on the whole of good marketable quality, but show minor defects which can no doubt be remedied without great difficulty. They would be readily saleable to-day at the prices given above, but it should be noted that these values are exceptionally high, based on current prices, and it is not possible to say how long the market will be maintained at the present level.

NOTES

North Borneo Timbers.—Little information on the timbers of North Borneo has been available in recent years and "The Timbers of North Borneo," by H. G. Keith, published as *North Borneo Forest Records*, No. 3, 1947, is very acceptable and has come at an

opportune time. The primary object of the publication is to present in a form as concise as possible facts regarding the more useful timbers of the Colony.

In the first part of the book a general description is given of the forests in which the commercial export timbers of North Borneo occur: these are confined chiefly to the East Coast and are classified as tropical lowland evergreen rain forests and are extremely complex. The most important species found belong to the Dipterocarpaceae and of the thirteen commercial (export) timbers eleven belong to this family. Owing to shifting cultivation and annual burning on a much wider scale than in the forests of the East Coast, the original West Coast forests have been destroyed and have been replaced by secondary forests with entirely different predominant species. These forests supply a large part of the timber requirements of the West Coast and also produce considerable quantities of minor produce.

Part II comprises a list of the commercial export timbers, arranged according to their approximate hardness, weight and durability. Red seraya is the softest, lightest and least durable of the timbers of North Borneo and billian is the hardest, heaviest and most durable. Particulars of the official, vernacular and other names by which each is known, botanical identity, description of the tree, characteristics of the wood, its mechanical properties, uses, log sizes for each of the thirteen timbers are supplied, and minor products obtained from the trees are referred to.

For convenience of comparison, details of the mechanical and physical properties of teak, oak and Scots pine are included.

The timbers discussed in Part III are the more common of those which are used locally or exported only to a small extent. Brief descriptions of each tree, the wood and its uses are given. Many of the timbers listed are stated to be used locally only because better species are not available.

R. M. J.

Australian Timbers.—The need for a comprehensive account of the principal timbers of Australia has long been felt and the appearance of "*The Commercial Timbers of Australia, Their Properties and Uses,*" by I. H. Boas, is very welcome.

The book is divided into two parts the first of which deals with the general technology of the timbers, the structure of wood, the physical and mechanical properties of Australian woods, their seasoning, durability and preservative treatment. The methods of bending wood are discussed, the veneer and plywood manufacturing industry is reviewed and the grading of the timbers dealt with. In addition this section of the book contains useful facts on the manufacture of paper from Australian hardwoods, a note on "improved" wood, a short account of local essential oils and other miscellaneous products related to the timber industry.

The second part of the book describes the individual timbers and the characteristics of each, with particulars of their density, shrinkage, durability, conditions of seasoning required, the principal uses and information with regard to their availability.

The final chapter is concerned with timbers for specific purposes.

R. M. J.

Advances in Grassland Husbandry and Fodder Production.—In August 1944 the Imperial Bureau of Pastures and Forage Crops published as Bulletin 32 a symposium of fourteen papers dealing with the above subject. The central theme of this collection is the provision of fodder for animals from cultivated crops or natural vegetation. In May 1947 this Bureau published a Second Symposium of 83 pages as Bulletin 38. Of the fifteen items in this Bulletin four are articles and the remainder either reviews or quotations.

Of the four articles two have been published in this country for the first time. One of these deals with the research programme on veld and pasture management in Southern Rhodesia. In this Colony there is envisaged a Central Research Station in each of the two provinces, Matabeleland and Mashonaland, into which the country is politically divided. O. West is responsible for the section of the paper treating of the proposed work at the Research Station on the Rhodes Matopo Estate in the former province, while J. M. Rattray covers the programme for the Station at Marandellas which serves the other province. Both programmes have the common object of determining the best methods to be employed to furnish better grazing for the livestock in the country. The other original paper by A. Kauter has as its subject forage production in Switzerland. In it is presented a short review of agriculture in that country before the war, special reference being given to forage crop production. Then follows a description of the transformation which took place during the war to make the country independent of foreign supplies. The article concludes with a consideration of post-war conditions, particularly as regards forage production, and with a brief note on the problems still to be solved.

The third article is a reprint of a paper by A. W. Ashby on the economics of ley farming, which originally appeared in *Farming* (1946, 1, No. 2). In it the author continues the discussion begun in *Imperial Agricultural Bureaux Joint Publication*, No. 6. A comparison is made between the cost and returns from ley farming and permanent pasture and information is given regarding the economic conditions which favour these farming systems respectively.

The fourth of the articles is an English translation of an exploratory article originally written by the Bureau's Russian Corresponding Editor, I. S. Travin. It bears the title "The Present Centres of Intensive Formation of Plant Species" and in

it is discussed the question whether "a comparison of the systematics and geography of wild and cultivated plants with maps of the present zones of intensive geological activity gives convincing evidence of the relation between the present centres of intensive geological action in the earth's crust and intensive species formation." The evidence presented appears to bear out the truth of this statement.

G. T. B.

Shrubs and Trees as Fodder.—It is well-known that there exists to-day a shortage of cattle and sheep, due partly to the effect of the war and partly to a higher standard of living for many people. This shortage is reflected in the insufficiency of meat supplies and of hides and skins, essential for the leather and allied industries. To overcome this deficiency it is necessary to increase the number of live-stock and to improve their strains. Such an increase will call for an ample acreage under pasture and fodder crops supplemented by adequate quantities of feeding-stuffs.

It has been established that more animals feed on shrubs and trees than on pastures, but in some countries, particularly semi-arid ones, there is gross overstocking, with the resultant deterioration in vegetative cover and a serious reduction in the capacity of the vegetation to prevent erosion of the soil by wind and water. It is most important therefore that every effort should be made to maintain, and if possible to increase, the amount of shrub vegetation.

The most efficient method of management of shrub vegetation still remains to be worked out. In this connection difficulty is experienced in countries, such as semi-arid lands, where there are no alternative fodder plants and where cattle are necessary for feeding the people.

Forest grazing presents problems of its own. These include the provision of sufficient herbage for the cattle, while at the same time safeguarding the establishment of seedlings; and the protection of catchments and the reduction of fire-hazards. These problems apply particularly to the United States and to India. In some countries such as those around the Mediterranean, forestry and grazing are incompatible.

The prevention of soil erosion by the maintenance of a perennial shrub cover has been worked out in parts of South Australia. Artificial re-seeding has not been found successful. The control of the number of sheep per square mile is the method advocated. In New South Wales, for the successful regeneration of depleted shrub areas, protection of grazings by fencing, the exclusion of rabbits and artificial plantings are the measures recommended. In Western Australia certain marginal zones and sandy coastal areas have been reclaimed by incorporating such perennials as *Kochia brevifolia* and *Atriplex semibaccata* in pastures where annual grasses and minor herbs deteriorate in yield if left uncultivated for long periods.

In some countries, such as the United States and South Africa, bush encroachment on grazing lands is a serious problem. Measures for eradication include digging out, burning, the use of herbicides and controlled grazing.

This subject of shrub and trees for fodder is of such importance that the Imperial Bureau of Pastures and Field Crops, Aberystwyth, the Imperial Forestry Bureau, Oxford, and the Imperial Bureau of Animal Nutrition, Aberdeen, have issued a *Joint Publication* (No. 10 of 1947) on it, under the title "The Use and Misuse of Shrubs and Trees as Fodder." In this publication a review is given of the present state of knowledge and experience. Some sections have been written in the collaborating Bureaux and others by specialists in different countries concerned with the problem. The countries considered include Canada, Australia, New Zealand, South Africa, India, Ceylon, Mediterranean countries, the Near and Far East, U.S.S.R., and the United States of America. No reference is made to Latin America, as *Bulletin* No. 36 of the Imperial Bureau of Pastures and Field Crops, entitled "The Grasslands of Latin America" covers these countries. Included at the end of this publication are tables showing the chemical composition of nearly 900 fodder shrubs and trees. These show that the nutritive values vary less among shrubs than among different kinds of pasture.

G. T. B.

The Determination of Pyrethrins.—Reference was made in this BULLETIN (1947, **45**, 23) to the work which has already been carried out by officers of the Imperial Institute in collaboration with other chemists on "The Determination of the Factor for Pyrethrin I in the Mercury Method." The results of this collaborative work have now been published with the above title by G. T. Bray and F. Major of the Imperial Institute; S. H. Harper of King's College, London; K. A. Lord of Rothamsted Experimental Station; and F. H. Tresadern, of Messrs. Stafford Allen and Sons, Ltd., in the *Journal of the Society of Chemical Industry*, 1947, **66**, 275.

In response to an invitation from the Standing Sub-Committee on Methods of Analysis of Vegetable Insecticides, Imperial Institute Consultative Committee on Insecticide Materials of Vegetable Origin, chemists throughout the world, who have experience in pyrethrin analysis, have agreed to carry out further collaborative work. The countries represented are: United Kingdom, South Africa, East Africa, Malaya, India, New Zealand, Canada, Australia, United States of America, Belgium, Belgian Congo, France, Holland and Java.

A programme of collaborative work has been drawn up by the Standing Sub-Committee for the purpose of testing the most promising methods of pyrethrin determination. Under this scheme of work the Standing Sub-Committee are distributing two samples of ground flowers, one new and one old. Analyses are to be made by

the following methods: (1) A modified Mercury Reduction Method; (2) The Seil Method as revised in 1947; and (3) The Ripert Method, re-written in 1947. It is proposed that, as far as is possible, the collaborators will work simultaneously on the same sample of flowers.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

NATURAL PERFUME MATERIALS. By Dr. Y. R. Naves and G. Mazuyer. Translated from the First French Edition (1930) by Edward Sagarin. Pp. xvii + 338, 9 × 6. (New York: Reinhold Publishing Corporation; London: Chapman & Hall, Ltd., 1947.) Price 40s. 6*d*.

This book deals comprehensively with natural perfume materials (floral oils and resinoids) obtained by digestion, enfleurage and extraction with volatile solvents as distinct from the essential oils obtained by steam distillation or expression. It is thus complementary to Gildemeister and Hoffmann's well-known standard work, *Die Aetherischen Oele*, which, although now including a chapter on flower perfumes obtained by extraction, enfleurage and maceration, does not describe the individual floral products and is concerned almost entirely with volatile oils and their isolates resulting from distillation methods.

The subject matter of the work now under review is treated under four sections, the first three devoted to: The history of the natural perfume industry from the Byzantine era onwards, including the raw materials (odoriferous plants, oils, fats and solvents) and the evolution of the various processes employed, which provide most interesting reading; modern processes of manufacture (chiefly centred in the south of France, in Grasse and its environs) of pomades, flower oils, concretes and absolutes; and the chemical composition and analytical examination of the various products, where modern methods of examination and the interpretation of results are dealt with in a most competent manner.

The fourth and largest section, of 140 pages, consists of monographs of the individual flower oils including, to mention but a few, those of cassie, jasmin, jonquil, mimosa, orange flowers, rose, tuberose and violet, the plant resinoids, for example, benzoin, cocoa, costus, tonka bean, oakmoss, orris, tobacco and vanilla, and the four animal resinoids, ambergris, castoreum, civet and musk. In these monographs a great deal of hitherto unpublished analytical and economic data is given and references to published work are listed at the end of each monograph.

The book is furnished with indexes of botanical names, authors

and subjects which, with the references given after each chapter, and the 45 photographs, diagrams and graphs, greatly increase the usefulness of the work.

Natural Perfume Materials provides a masterly survey of the floral products industry made by two acknowledged experts on perfumery, one a chemist and the other a perfumer, and the translation has been very ably carried out. The book is destined to become the recognised standard work on the subject and will prove of great assistance to those concerned with the installation, direction and control of modern perfume extraction plants, whilst research chemists working in the essential oils field will find in it much of value.

H. T. I.

THE WATER-SOLUBLE GUMS. By C. L. Mantell, Ph.D. Pp. v + 279, 9 × 6. (New York: Reinhold Publishing Corporation; London: Chapman & Hall, Ltd., 1947.) Price 36*s*.

In the first chapter, " Classification and Chemistry of the Gums," the author regards as water-soluble gums those hydrophilic substances, directly or indirectly, of plant or animal origin, which form viscous, colloidal solutions with water or swell to jellies. This has entailed consideration, not only of the natural tree exudations (gum arabic, karaya gum, gum tragacanth and so on), but also seaweed products (agar-agar, Irish moss and the alginates), the hemicelluloses (locust bean gum, Iceland moss, and extracts of seeds such as flax, psyllium and quince), certain ethers obtained chemically from cellulose (methyl, carboxymethyl and hydroxyethyl celluloses), the heat or chemically modified starches (dextrin and British gum) and the water-dispersible proteins (gelatin and glue).

In nine chapters the sources, preparation, marketing and properties of this formidable list of natural and manufactured products are described, whilst four further chapters are given over to consideration of their uses in cosmetics and pharmacy, in paints and coating compositions, in textile operations and in miscellaneous ways, whilst specifications for the materials, their identification and testing are dealt with in another chapter. A list of local names for the gums, with places of origin, source (usually the botanical genus) and present day classification appears as Chapter 16, in addition to the usual botanical, author and subject indexes. The book is illustrated by a number of photographs showing the collection, sorting and grading of gums, the seaweeds and their treatment, and is provided with numerous diagrams and tables, whilst a large number of references to the literature consulted are given as footnotes throughout the work.

Between the covers of this book will be found a great deal of information on the materials dealt with, though it is a pity that attempts were not made to reconcile the conflicting statements of

some of the authorities quoted. It was impossible, however, adequately to cover such a wide field in a book of this modest size, and the author would have been wiser to restrict the scope of his work to gums of direct plant origin (the natural exudations and, possibly, the hemicelluloses and seaweed products), leaving those obtained by chemical manufacturing processes and the proteins for other volumes. The result of including so many diverse substances is that the book lacks continuity and the information provided is often inadequate. This is particularly the case in regard to the chemistry of the gums, which is treated in a very scrappy manner.

Attention is drawn to a number of errors. Fig 2 (page 22) is upside down. This and Figs. 3-6, which are shown by courtesy of the Philadelphia Commercial Museum, were all originally published in the Third Report of the Wellcome Research Laboratories, Khartoum, 1908, the pioneer work of which organisation was, apparently, overlooked.

In Table 14 (p. 85) identical figures are shown for the composition of Japanese Saghalien and Kobe agars as received, and those for the former do not accord with the figures on the dry basis. Table 15 (p. 86) shows only two types of agar, whereas three are referred to at the bottom of page 85.

In Table 33 (p. 179) α-aminoacidic acid should be amino acetic acid and the headings "dibasic monoacidic" and "monobasic diacidic" reversed.

On page 239 the composition of the reagent (0·001 per cent. solution of acenaphthene-5-carboxylic acid in conc. sulphuric acid) used by Radley for identifying gums by flourescence is omitted.

In a number of cases the temperature at which viscosity determinations were made is omitted; on the other hand a temperature of 22·22° C. at which chromium and beryllium alginates are stated to have been stored (Table 17, p. 118) is hardly likely and probably results from a too literal conversion of 72° F.

The author has set himself the task of bridging the gap between art and science in the gum field. He has not been entirely successful in this but, nevertheless, his book should prove of assistance to those concerned with gum technology.

H. T. I.

PRACTICAL BRITISH FORESTRY. By C. P. Ackers, M.A., B.Sc. Second Edition. Pp. xviii + 394, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: Geoffrey Cumberlege; Oxford University Press, 1947.) Price 20s.

This book, the first edition of which was published in 1937, is essentially concerned with private forestry in Britain and in addition to those already concerned with forestry, will be extremely useful to the landowner, agent or student dealing with the practical and administrative affairs of estate forestry. The author is a firm believer in the possibility of making British forestry financially profitable and stresses the need for the efficient use of private forest

land for greater productivity in order that its absorption by the State will not become inevitable.

In the opening chapters accounts of the various species of trees of our forests are given, one each being devoted to hardwoods and softwoods. Brief cultural notes on each species are supplied with particulars of the properties and uses of the respective timbers.

The chapter on nursery work, of especial value to foresters, is followed by those containing full information on planting and establishing, and detailed accounts of thinning and pruning methods, with illustrations. The extraction, conversion and sale of timber are also dealt with. The author gives an account of the war-time difficulties and problems of this country and lessons to be learned therefrom. He considers what is required is " careful thought in bringing in wise legislature and governmental guidance in the following fundamentals :

1. The establishment of higher-class plantations through higher-class nursery methods.
2. The laying-out of any future war-time fellings, with the intention of conserving wherever possible all stands, whether they have to be over-thinned or not, that would be essential for the welfare of future generations.
3. The conservation in peacetime of our limited forest resources, till they are adequate against any emergency.
4. The fostering of a healthy home-grown timber trade with which the Government keeps the closest touch, so that it is the body to whom the Government turns for great and rapid expansion in times of stress."

There is an appendix to the book containing useful measurements and figures, particulars of the Forestry Commission Scheme for the Dedication of Woodlands and a Glossary of Terms.

The book makes interesting reading, is well illustrated, and can be recommended to those interested in forestry overseas as well as in this country.

PLASTICS MANUAL. By H. R. Fleck. Pp. xxix + 155, $8\frac{1}{2} \times 5\frac{1}{2}$. (London : Temple Press Ltd., 1947.) Price 15*s*.

The aim of the author has been to provide in a few pages the maximum amount of information possible on the various substances employed in the plastics industry, from the raw materials to the final products. The scope of the book is restricted to the two main divisions, thermo-plastic and thermo-setting, of plastic materials ; synthetic elastomers are intentionally omitted. The arrangement is such that the information desired by the reader is readily found, generally in one place for any particular plastic material.

After a brief introduction, separate chapters are devoted to a review of the progress of the plastics industry since Baekeland's discovery of the phenol-formaldehyde resins early this century ; to a consideration of the basic raw materials (coal, limestone,

petroleum, sand, etc.); and to particulars of the synthetic resins grouped as follows:— acylic, allyl, amino resins, cellulose plastics, miscellaneous resins (coumarone-indene, ketone and organo-silicon), phenol resins, poly-ethylene, poly-styrene and vinyl plastics. In each case the preparation and properties of the parent compound, intermediate products and the final resin or plastic are described with, in most cases, the equations for the chemical reactions involved. The uses to which the plastics are put are also given. Other chapters cover synthetic cements and resins, densified wood, fillers, and the qualitative analysis of plastics. The mechanical side of the industry (moulding and the production of moulds) is also dealt with briefly and there is a useful list giving the definitions of some of the terms employed.

Throughout the text 31 tables show the physical and electrical properties of the manufactured products, whilst two further tables give, respectively, the constants of 100 plasticisers and their compatability with various natural and synthetic resins. These last two tables are reprinted from the second edition of *Plastics—Scientific and Technological* by the same author (reviewed in this BULLETIN, 1946, **44**, 26), and it is a matter for regret that the opportunity has not been taken to make the last table inclusive of all the plasticisers mentioned in Table 32.

The author is to be congratulated on the clear, concise form in which the subject matter is presented. The book will have a wide appeal, not only to chemists and physicists engaged on problems in the plastics field, whether in the industry itself or in the numerous applications of plastics, but also to many less directly concerned who will find in it much of interest.

H. T. I.

THE NEW FIBERS. By Joseph V. Sherman and Signe Lidfelt Sherman, M.S. Pp. ix + 537, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1946.) Price 28*s*.

During the last ten years many synthetic fibres have been developed from the laboratory stage and are now obtainable commercially. The properties of these new fibres differ considerably and they have different uses. Information on them until now was to be obtained only from scattered articles in technical journals or from the various manufacturers. There has been an urgent need for a source of information on these new fibres, in which prospective users could find assembled together the information regarding their properties, strength, uses, cost, etc., so that easy comparison could be made between them and a selection made according to the use for which they were required.

This book has met this need. It deals with all the new synthetic fibres, separate chapters being devoted to Nylon, Vinyl Resin, Vinylidene, Glass, Polyethylene, Casein, Soybean and other

synthetic fibres. In each chapter information is given on the development, method of manufacture, properties, uses, extent of production and the price. This information is presented clearly in a manner which can be understood by readers without too much technical knowledge and for those who wish to go further into the technical aspects, at the end of each chapter there is a useful list of references.

Other chapters deal with Rayon, which in view of the great improvements which have been made in recent years in the fibre, is rightly included by the authors as being among the new fibres: with the chemical treatment of fibres: with certain vegetable fibres such as Ramie, Milkweed floss, etc., which, although not new, are now being considered from fresh angles. In addition there is also a most useful appendix containing a list of various patents relating to the fibres dealt with in the text. This appendix covers 138 pages and by itself would be a most useful publication.

The book contains some excellent photographs and is well furnished with useful tables. One criticism the reviewer has to make is that the information relates almost entirely to the U.S.A. No doubt future editions will deal more fully with developments in synthetic fibres in other countries. Another small criticism relates to the index. Although information is given in the text on the use of Nylon, Vinylate resin, and other fibres for brushes, ropes and filter cloths, there is no quick way of finding from the index where to look for information on these subjects. More cross-indexing of uses, for example, would help the reader who, although he knows for what use he requires a fibre, has no idea which of the many new fibres is likely to meet his purpose. It is suggested that in any new edition the index should be improved since a book which contains so much useful information deserves an adequate index. These small criticisms are meant not to detract from the value of the book, but as suggestions for any future edition.

This book fills a gap in the books on fibres and is to be highly recommended to those who are concerned with fibres of all kinds, whether synthetic or natural.

R. H. K.

NATIVE ECONOMIES OF NIGERIA. By Professor Daryll Forde and Dr. Richenda Scott, edited by Margery Perham. Pp. xxiv + 312, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Faber and Faber, Limited, 1946.) Price 25*s*.

This book, which is the first of two volumes of a study of the economies of a tropical dependency has been prepared under the guidance of the Nuffield College Colonial Sub-Committee. The whole work is the result of investigations carried out by a team of research workers who have made an intensive survey of the economies of Nigeria. That country was selected for study on

account of its size, problems and position among colonial dependencies. This first volume contains a general introduction to the whole survey by Miss Perham, a study of the native economic system by Professor Daryll Forde, and a study of Nigeria's production for trade by Dr. Richenda Scott. Mining, Commerce, and Finance form the subject of the second volume.

In the course of these studies a great wealth of published and unpublished material has been worked over in addition to investigations undertaken in the field. The general picture is of peasant populations with extremely limited resources, supported largely by subsistence farming under conditions in which the normal peasant household has been unable always to count on obtaining an adequate diet. The work lays bare much of the position of the pre-war Nigerian economy. Above all it shows the importance of such surveys if a proper understanding of Colonial peoples and their problems is to be obtained. Much evidence is provided regarding the directions in which improvements in the standard of living should be attempted.

The studies make clear the formidable problems that have to be overcome in order to obtain advances in economic conditions. There are generally no simple methods to obtain improvement. For instance, the promising movement towards peasant-owned plots of planted palms in the Southern Provinces which has been sponsored by the Agricultural Department for a number of years, has been checked by the decline in yield that has appeared in most areas when plantations reach the age of 9-12 years. This is attributed to the low fertility of the acid soils of much of the palm belt, which apparently cannot support plantation palms without a measure of manuring, a course at present impracticable under Nigerian peasant farming conditions. Advances in agricultural practice here, as elsewhere, require long periods of experimental trial, and in particular it is necessary to provide supervisory staffs without which improved methods cannot be put into operation on peasant holdings. As is well recognised the scale of crop investigation and research has been inadequate in the past, but again taking the oil palm as an instance, the provision in Nigeria of a research station, say, in the early twenties, would surely have involved an expenditure disproportionate to the then cost of the entire Department of Agriculture.

Thus regarding the criticism on page 236, "that there has been prolonged neglect to initiate adequate oil-palm research in West Africa," it would perhaps be preferable to say that only in recent years has it been possible to contemplate agricultural research and investigations on a scale commensurate with the problems to be solved.

The work appears free from serious errors but there are a few minor mistakes, e.g. Miss Perham, in her introduction appears to attribute the Veterinary Department's work at Vom to the

Agricultural Department, and in exchange the latter department's responsibility for the Ilorin Stock Farm to the former. Later in the text Vom appears as a Veterinary station. Since the book was prepared for publication swollen shoot disease of cacao has been found in Nigeria. There is rather a large number of footnotes and these at times seem to be of excessive length. The consecutive numbering of the literature cited in the text might have been an advantage. E. H. G. S.

THE USE OF AERIAL SURVEY IN FORESTRY AND AGRICULTURE. By J. W. B. Sisam. Joint Publication No. 9. Pp. 59 + 67 plates, $9\frac{3}{4} \times 7\frac{1}{2}$. (Imperial Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, 1947.) Price 7*s.* 6*d.*

Since 1914-18, when aerial photography was first applied on a practical scale, considerable progress has been made in this art, and its uses have been greatly developed. Among the purposes to which aerial photography has been put since those days is that of carrying out aerial surveys in forestry and agriculture. The information supplied by such surveys is of great importance when the development of the Colonies is being considered. By this means a more accurate presentation of prevailing conditions of the forestry and agriculture of a district can be obtained more rapidly than by a ground survey. Not that the latter method can now be discarded, but the two means of survey should be complementary.

The introduction to this Bulletin describes the advantages that aerial photography possesses and also details its limitations. Factors affecting the efficiency of this method of survey are discussed in a succeeding chapter, where the advantages and disadvantages of the types of aerial photography are discussed, namely, verticals, high and low obliques and composite (multi-camera). The cost of aerial surveys is also considered in this chapter, where it is stated that there is evidence to show that for relatively large areas this new method can be used at a somewhat smaller cost than that of ground surveys and yet giving usually more accurate and detailed results.

The chief use of aerial photographs is undoubtedly in the preparation of topographic and planimetric maps. Their interpretation and application are dealt with in Chapter III, where emphasis is placed upon the necessity of a skilled expert for this purpose. The final chapter describes the use to which aerial photographs have been put in land-use and vegetation surveys. Here reference is made to soil and horticultural surveys made in Australia; to land classification and forest surveys in Canada; to land-classification, vegetation and forest surveys in the United States; to forest surveys in the U.S.S.R.; and to surveys made in some British Territories, namely, British Honduras, Cyprus, Nigeria, Northern Rhodesia, Nyasaland, Tanganyika, Trinidad and Uganda.

A list of nearly 100 references and a set of 67 excellent photographs showing various types and conditions of vegetation and land use and misuse in different parts of the world, particularly in the Tropics, complete the Bulletin.

The subject has been presented in a very readable form, and the reader in studying the contents of this Bulletin will gain very useful knowledge of the use to which aerial photography can be put in forestry and agriculture.

G. T. B.

THE DEHYDRATION OF FOOD. By T. N. Morris, M.A. Pp. vii + 174, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1947.) Price 15s.

Although at the outbreak of war in 1939 certain dried foods, such as dried vegetables; sun-dried raisins, sultanas, apples, apricots, prunes; roller-dried potato flour, dried full-cream milk and dried eggs were known there was little machinery, if any, and few experts available in this country or in the Empire for the production of important dried foods such as dried vegetables and meat. As a result of this deficiency considerable research had to be carried out in this country and the United States. This work was essential in order to establish the most suitable conditions for drying various foods and for the storage of the dried products so that the loss of their nutritive and culinary properties might be reduced to a minimum. As a result of this research there has been found a reliable alternative to canning and refrigeration as a method of preserving foods. In Great Britain the Food Investigation Board of the Department of Scientific and Industrial Research working at the Low Temperature Research Station, Cambridge, and the Torry Research Station, Aberdeen, were primarily responsible for this investigation, in which they received collaborative assistance from the Dunn National Laboratory, Cambridge, and the Ministry of Food.

The author of this book, who worked on this problem at the Low Temperature Research Station, Cambridge, has now published in this volume a great deal of the knowledge resulting from this research. In the opening chapters the author deals with the nutritive values of a number of foods and then goes on to consider the characteristics of biological materials, outlines the general principles and methods of dehydration and describes the various types of driers used. Then follow two chapters devoted to a full account of the dehydration of vegetables and of animal products. The importance of the proper storage of dehydrated foods is emphasised in another chapter, and desiderata enumerated for ensuring that they are kept from deterioration, which also depends upon the methods of packaging. These are described in a chapter to themselves. Tests are given for the examination of the chief dehydrated foods, each food taken separately in this chapter as is done in others.

The final chapters deal with the bacteriological aspects of dehydration and the control of insects infecting these products. A table of dehydration data is given as an appendix. The book is furnished with bibliographical references at the end of each chapter; with a number of illustrations; and an index.

This book gives a very good account of the principles and methods of dehydration, together with a considerable amount of relevant information. It is a valuable addition to the literature on this subject and can be thoroughly recommended for study by all those engaged in this industry.

G. T. B.

Concise Chemical and Technical Dictionary. Edited by H. Bennett. Pp. xxxix + 1055, $9\frac{1}{4} \times 6\frac{1}{4}$. (New York: Chemical Publishing Company, Inc., 1947.) Price $10.00.

This dictionary is intended for professionals and laymen and every intelligent person who wants to understand any technical expression found in his reading. It is stated to contain about 50,000 definitions covering every field of scientific and technical development. It is claimed that the definitions are concise, clear and to the point. A cursory perusal of this book shows that in some cases the entries are too concise and do not give a satisfactory definition. For example, China wood oil is stated to be a "yellow oil obtained from Chinese seeds." No mention is made whether the seeds grow on a tree or on a plant, while the botanical indentification of the two trees concerned is not given. No reference is even made to the considerable production of this oil in the United States. Derris is described as a "poisonous root," and no further information is vouchsafed about it. In spite of its being used extensively in America and elsewhere as an insecticide, this use is not mentioned under the heading of "derris," but under "rotenone" we read that this compound is an "active insecticidal ingredient of derris root, cubé, etc." If one then looks up "cubé" in this dictionary, no entry will be found, although this is another insecticidal material well known in American commerce. For definitions of some materials, the reader is referred to another entry. For instance, under "soybean" the reader is told to see "soya" but he will fail to find this mentioned. "Caroban" is described as "carob seed gum," but no definition of this gum is given.

There are other materials which one would expect to find included, such as Manila hemp, Mexican fibre, cashew nut shell liquid. There is no entry for corozo nuts (*Phytelephas macrocarpa*) although this botanical name is quoted under the heading of vegetable ivory. Under "wattle" the only country mentioned is Australia, although large quantities are grown commercially in East Africa. No details are given of the source or preparation of wool wax. Under "castor oil" no reference is made to its being dehydrated to give a varnish oil although under "dienol" the

reader is informed this product is dehydrated castor oil used in varnish. The botanical source of a number of products is not given.

Mistakes occur. China wood oil is stated to consist chiefly of the glycerides of oleic and oleomargaric acids. The main acid, as is well known, is elaeo-stearic acid. Incidentally, if the reader looks up in this dictionary to find out what oleomargaric acid is, he will not find it. Carnauba wax is described as being derived from the South American pine. The tree is really a palm. Chicle gum does not come from *Mimusops balata* but from *Achras sapota*. Chaulmoogra oil is not an essential oil but a fixed oil. Mutton tallow and suet are not the same as lard. Palm oil in the modern processes is not obtained from fermented pulp. Nowadays every effort is taken to prevent the pulp fermenting, seeing that an oil of low free acidity is desired. The plural of "genus" is "genera," not "geni."

The above results of a cursory glance through this dictionary show that it is not as reliable a source of information as might be expected. Before another edition is published, every effort should be made to have the contents thoroughly revised by competent experts on the various subjects covered.

G. T. B.

THE EVOLUTION OF GOSSYPIUM AND THE DIFFERENTIATION OF THE CULTIVATED COTTONS. By J. B. Hutchinson, R. A. Silow, and S. G. Stephens. Pp. xi + 160, $8\frac{1}{2} \times 5\frac{1}{2}$. (London, New York, Toronto: Geoffrey Cumberlege, Oxford University Press, 1947.) Price 15*s*.

In 1926 the Empire Cotton Growing Corporation started at the Cotton Research Station, Trinidad, their fundamental botanical and genetic studies on cotton as it was recognised that comprehensive studies of this nature were required if an adequate foundation of knowledge was to be provided for the cotton breeder. The programme followed since the inception of the scheme proceeded along three lines. Firstly, cottons and cotton relatives were collected from all parts of the world and used in reviewing the current classification of the genus. The second line was a genetics programme to elucidate the differences in gene content responsible for the variation in cultivated cottons. The third line developed from the other two and concerned the wider relationship of the wild and cultivated species. The results of these investigations have appeared from time to time and are collected together in the *Memoirs of the Cotton Research Station, Series A, Genetics*.

The Cotton Research Station in Trinidad was closed in 1944 as it was decided to continue research on the genetics of cotton at a place nearer to the commercial crop in Africa. It was therefore considered opportune to write this book in which is given a review of the genus Gossypium as a whole together with an account of its

evolution and present status. The book is divided into four parts under the headings: The classification of the genus Gossypium; The evolution of the species of Gossypium; The differentiation of the true cottons; and the significance of Gossypium in evolutionary studies. It is written by three experts who worked at the Cotton Research Station, Trinidad, and forms a fitting final report of the Genetics Department of that station. It should prove of great value to all concerned with the planning of cotton breeding work.

G. T. B.

Soil Erosion in New Zealand. By Kenneth B. Cumberland, M.A. (London), D.Sc. Second Edition. Pp. 228, $8\frac{1}{2} \times 5\frac{1}{2}$. (Christchurch; Melbourne; London: Whitcombe and Tombs, Limited, 1947.)

About two-fifths of the area of New Zealand is suffering from the effects of soil erosion. This serious state of affairs has been brought about by indifferent management. It is all the more serious because this Dominion is so largely dependent upon its soil for the production of her articles of commerce, the quantity of manufactured goods being very small. Although soil erosion has been evident for a number of years it was only in 1938 that any official attention was paid to it, three years after the establishment of an independent Soil Survey Division.

In this book the author, who has been studying this question in New Zealand for six years, describes the present state of soil erosion. He considers each Island separately, in each case the area being divided into four regions. Then after this description of the present state of affairs, he goes on to outline his suggestions for controlling soil erosion and for preventing it. Among the methods suggested is the planting of quick-growing exotic conifers, in place of *Pinus radiata*, an inferior timber tree, the establishment of which has already given successful results in some parts of this Dominion. Another suggestion consists in the growing of tougher and more resistant grasses to give denser and more productive pastures, while allowing cattle instead of sheep to graze in some districts is a further proposal. Contour furrows and better husbandry and improved practices will also help.

Appendixes deal with geologic and surface characteristics, climatic characteristics, and soil characteristics affecting the incidence and morphology of soil erosion in New Zealand.

The book is very well got up and is illustrated with 60 excellent photographs showing the effects of soil erosion, and with 10 figures. It is well written and very informative, and it is hoped will stimulate the taking of efficient steps to prevent soil erosion and to repair the damage already done.

G. T. B.

CHEMICALS, HUMUS, AND THE SOIL. By Donald P. Hopkins. Second impression. Pp. 278, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Faber and Faber, Limited, 1946.) Price 12*s*' 6*d*.

The controversy over the respective merits of natural manures and chemical fertilisers has existed for a number of years. One school upholds that natural manures furnish all the manurial requirements of the soil, while the other school maintains that artificial fertilisers alone are necessary for this purpose. The author in this book discusses this question not primarily for the sake of scientists and technicians of agriculture but for the ordinary man interested in the raising of crops. It is therefore written in as non-technical language as possible.

The book is divided into two parts. The first is devoted to the case for the use of fertilisers and includes a consideration of the general principles of soil fertility maintenance. The second part examines the case against the use of chemicals, among the disadvantages of which are claimed to be the poisoning of the soil, the increase of disease and a reduction of nutritional value. Evidence is presented to substantiate the claims of both sides and further evidence is provided to disprove these claims.

Although the author is a chemist concerned in the production of chemicals used as fertilisers, he has presented the case for artificials in a way commendably free from pronounced bias. The reader cannot but agree with the opinion of the author that natural manures and artificial fertilisers are supplementary to one another. This opinion has been corroborated by the Parliamentary and Scientific Committee in their report "A Scientific Policy for British Agriculture" which was published after this book was written.

G. T. B.

THE NATIONAL PAINT DICTIONARY. By Jeffrey R. Stewart, F.A.I.C. Third Edition. Pp. 704, 9×6. (Washington, D.C.: Stewart Research Laboratory, 1948.) Price $7.50.

This dictionary is written especially for manufacturers, distributors and consumers of paints and varnishes in order to supply them with information on the various raw materials used in these industries; with definitions of scientific and technical terms employed in connection with them; and with descriptions of the finished products. In the compilation of this work, the author has obtained his material not by consulting published literature but from the opinions of a cross-section of leading scientific and technical men in the industry. Although this method involved a great deal of effort and time, the results have justified the trouble taken. The terms included in this dictionary fall within the six categories: industrial raw materials used in the paint, varnish and allied industries; trade names of raw and finished products; terms describing processes and methods; scientific instruments used in testing;

terms denoting physical properties, such as colour, and optical properties; and miscellaneous.

A cursory perusal of this dictionary shows it to be practically free from errors and to give adequate information on the many items mentioned. The only serious mistake noticed is on page 535, where the chemical composition quoted for soy bean oil is really that of soy beans. An improvement that might be introduced into future editions is that the information given under the headings starting "gum" should be the same as that supplied under the particular name of the gum. For example, under "Congo Copal" some details are included, but additional particulars follow "Gum Congo." This criticism applies also to Boea, Dammar, Elemi, Kauri, Mastic and Pontianak.

Notwithstanding the above remarks this dictionary can be thoroughly recommended and should prove of considerable use and value to those for whose sake it has been compiled.

G. T. B.

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Indian Santonica. Cultivation and Collection in the Kurrum Valley. By N. A. Qazilbash. *Pharm. J.*, 1947, **159,** No. 4375, 169-170.

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Cheesemaking in New Zealand. By J. J. Walker. *N.Z. J. Agric.*, 1947, **74,** No. 6, 549-555.

The World's Casein Position and Outlook. *Oil, Col. Tr. J.*, 1947, **112,** No. 2549, 416, 418.

FORESTRY

General

Empire Forests and the War. Statement prepared by the Forests Commission of Victoria, Australia, for the Fifth British Empire Forestry Conference, London, 1947. By A. V. Galbraith. Pp. 93 + 8 maps. (Melbourne: Government Printer, 1947.)

The Place of Forestry in Land Utilisation in Australia with special reference to Soil and Water Conservation. By A. V. Galbraith. Paper prepared for the Fifth British Empire Forestry Conference, London, 1947. Pp. 11. (Melbourne: Government Printer, 1947.)

Forestry and Forest Resources, Western Australia. Statement prepared for the Fifth British Empire Forestry Conference, London, 1947. Pp. 57. (Perth: Government Printer, 1947.)

Annual Report of the Forest Commission of Victoria, Australia, for 1945-46. Pp. 40. (Melbourne: Government Printer, 1947.) Price 1*s.* 6*d.*

Annual Report of the Department of Lands and Mines, New Brunswick, for 1946. Pp. 136. (Fredericton, N.B.: King's Printer, 1947.) Contains the report of the Forest Service of the Province.

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Eucalypts and Their Use in Semi-Tropical Plantings. By F. R. Moulds. *Trop. Woods*, 1947, No. 91, 1-16.

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Timber Exploitation in the Gold Coast. By W. E. Logan. *Emp. For. Rev.*, 1947, **26,** No. 1, 30-53.

The Utilisation of Teak Thinnings from Plantations in Trinidad. By R. Smeathers and H. Tordoff. *Emp. For. Rev.*, 1947, **26,** No. 1, 79-82.

The Mahoganies. By H. E. Desch. *Wood*, 1947, **12,** No. 10, 288-290.

Sawdust-Cement and Other Sawdust Building Products. By T. W. Parker. *Chem. and Ind., Lond.*, 1947, No. 39, 593-596.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY OF INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 40

(July to September 1947)

Compiled by MISS R. M. JOHNSON

With the collaboration of the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

General

Rep. Dep. Agric. Trinidad, 1945. Describes field experiments conducted on insectidical control of froghoppers in which the insecticides studied were sabadilla and DDT both separately and in admixture with each other, p. 17; use of cube for treating cucumbers against attacks of *Diaphania* spp. and cabbages and cauliflowers against *Hellula phidilealis*, p. 18.

Investigations of several Insecticidal Sprays and Dusts for the Control of the Gooseberry Fruitworm on Currants and Incidental Observations on Cultural Control Measures. By J. L. Brann. *65th Ann. Rep. N.Y. St. Agric. Exp. Sta.*, 1946, p. 16. Four years experimentation have shown that rotenone is the only insecticide that can be recommended at present, either as dust or spray; DDT appears promising but more studies on its use necessary; ryanex gave poor control in 1945.

Control of the Oriental Fruit Moth in Peaches. By E. H. Wheeler and A. A. La Plante. *65th Ann. Rep. N.Y. St. Agric. Exp. Sta.*, 1946, p. 17. In order to determine the effect of insecticides on the parasite, *Macrocentrus ancylivorus*, of the moth, and the relative effectiveness of insecticides on the moth, experiments were conducted with DDT and ryanex.

Principles of Insecticidal Control of the European Corn Borer. By L. A. Carruth. *65th Ann. Rep. N.Y. St. Agric. Exp. Sta.*, 1946, p. 20. Extensive field comparisons made between dusts containing rotenone, ryanex and DDT.

New Insecticides for Control of Pear Psylla. By D. W. Hamilton. *J. Econ. Ent.*, 1947, **40**, No. 2, 234-236. A number of materials tested among the most promising of which were piperonyl cyclohexenone with 0.8 per cent. pyrethrins, cube root powder and a nicotine powder.

Recent Advances in Control of Ornamental and Shade Tree Insects. By S. W. Bromley. *J. Econ. Ent.*, 1947, **40**, No. 2, 237-239. A resin emulsion of pyrethrum and rotenone gave excellent control of a number of insects.

An Arsenic-Resistant Tick and Its Control with Gammexane Dips. By A. B. M. Whitnall and B. Bradford. *Bull. Ent. Res.*, 1947, **38**, Pt. 2, 353-372. Compares the effects of gammexane with other insecticides, including rotenone, nicotine and anabasine.

Les Plantes à Rotenone, les Pyrèthres et autres Plantes Insecticides. By M. Raucourt. *Rev. Bot. Appl.*, 1947, **27**, Nos. 297-298, 295-302.

A Spraying Apparatus and Testing Chamber for Investigating the Residual Action of Insecticidal Deposits. By J. E. Webb. *Bull. Ent. Res.*, 1947, **38**, Pt. 2, 209-232.

Aqueous Solutions of Insecticides of Vegetable Origin. Dutch Pat. No. 55,517. *Amer. Chem. Abst.*, 1947, **41**, No. 12, 3918. To disperse insecticides in water a capillary-active substance with a hydrocarbon chain of ten or more carbon atoms is added and boiling water used.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Oil-Soluble Copper-Nicotine Compounds and Process of Preparing Same. U.S. Pat. No. 2,414,213. *Rev. U.S. Pat. Pest Control, U.S. Dep. Agric.*, 1947, **20**, No. 1, 2.

Die San José-Schildlaus im Südtirol. By F. Schneider. *Schweiz. Z. Obst.-u. Weinb.*, 1946, **55**, No. 3, 50-56. (*R.A.E.*, 1947, **35**, A, Pt. 7, 201-202.) Control measures taken included post-blossom applications of a lime-sulphur spray containing 0.05 per cent. nicotine; fairly satisfactory results obtained.

Spray and Dust Treatment of Potato Demonstration Plots, 1945. By G. A. Brandes and E. M. Swisher. *Bi-Monthly Bull. N. Dakota Agric. Exp. Sta.*, 1946, **8**, No. 3, 33-39. (*R.A.E.*, 1947, **35**, A, Pt. 7, 229.) A mixture of DDT, a pyrethrum dust and a copper fungicide fairly satisfactory in controlling insects attacking potatoes.

Control of the Grape Leafhopper. By J. A. Cox. *J. Econ. Ent.*, 1947, **40**, No. 2, 195-198. Nicotine sulphate and lethane fairly effective, but did not prevent a build-up.

Observations on the Commercial Control of Onion Thrips on Onions. By A. D. Borden. *Circ. No.* 365, *Calif. Agric. Exp. Sta.*, pp. 46-48. (*Amer. Chem. Abst.*, 1947, **41**, No. 9, 2847.) Nicotine alkaloid one of the materials tested.

Controlling Thrips and Tomato Spotted Wilt with DDT. By M. W. Gordner and A. E. Michelbacher. *Circ. No.* 365, *Calif. Agric. Exp. Sta.*, pp. 35-38. (*Amer. Chem. Absts.*, 1947, **41**, No. 9, 2847.) DDT spray was more effective than nicotine fumigation in glasshouse cultivation.

Another Nicotine Substitute. *Manuf. Chem.*, 1947, **18**, No. 7, 289. (*Science*, 1947, **105**, No. 2724, 281.) Relates to tetraethyl-pyrophosphate (TEP), which is reported to be unusually effective against aphids and mites and other crop pests resistant to DDT.

Corn Borer Control. By N. Turner. *Bull. No.* 495, *Conn. Agric. Exp. Sta.* (*Agric. Chem.*, 1947, **2**, No. 5, 51.) Nicotine-bentonite diluted with pyrophyllite as effective as dual-fixed nicotine diluted with clay.

La Lutte contre les Vers de la Vigne en 1942 et 1943. By P. Bovey and H. Martin. *Terre vaudoise*, 1944. (*R.A.E.*, 1947, **35**, A, Pt. 6, 198.) Nicotine sulphate among the products tested.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Control of Cattle Grubs. By H. B. Mills, H. Marsh and F. S. Willson. *Bull. No.* 437, *Mo. Agric. Exp. Sta.*, 1947. Rotenone sprays effective against *Hypoderma lineatum*.

The Life History and Control of the Buprestid Cane Borers and Allied Insects attacking Raspberries. By F. G. Mundinger. *65th Ann. Rep. N.Y. St. Agric. Exp. Sta.*, 1946, p. 16. Rotenone a possible material for control after the fruit has formed; DDT best means of protection previous to blossoming.

Pea Aphid Control in Eastern Virginia. By L. D. Anderson and J. W. Brooks. *J. Econ. Ent.*, 1947, **40**, No. 2, 199-205. Rotenone-bearing dusts and sprays were found to be less effective than the better DDT treatments.

Investigation of Grape Insects other than the Grape Berry Moth. By F. Z. Hartzell and E. F. Taschenberg. *65th Ann. Rep. N.Y. St. Agric. Exp. Sta.*, 1946, p. 17. DDT more effective than rotenone spray.

Horticultural Spray Oil. U.S. Pat. No. 2,421,507. *Rep. U.S. Pat. Pest Control, U.S. Dep. Agric.*, 1947, **20**, No. 2. Composition contains rotenone.

Derris

The Colorimetric Evaluation of Derris Root. By T. M. Meyer and A. Rachmad. *Rec. Trav. Chim.*, 1947, **66**, 312-316.

The Protective Effect of Arsenic and Derris Dips against the Sheep Tick, *Ixodes ricinus* L. By J. MacLeod. *Ann. Appl. Biol.*, 1947, **34**, No. 2, 207-223.

Chemical Examination of Plant Insecticides. I. Chemical Components of *Derris ferruginea.* II. Chemical Components of *Derris scandens.* By N. V. Subba and T. R. Seshadri. *Proc. Indian Sci. Congr.*, 1946, **24a**, 344-348, 365-374. (*Amer. Chem. Absts.*, 1947, **41**, No. 10, 3250.)

Cube

Lonchocarpus à Roténone de l'Amérique du Sud. By B. A. Krukoff and A. C. Smith. *Rev. Bot. Appl.*, 1947, **27**, No. 297-298, 317-318.

Others

The Chemical Constituents of *Mundulea suberosa* Benth. Part I. By T. M. Meijer. *Rec. Trav. Chim.*, 1947, **66**, 177-183.

The Insecticidal Constituents of *Pachyrhizus erosus* Urban. Part I. By T. M. Meijer. *Rec. Trav. Chim.*, 1946, **65**, 835-842.

PYRETHRIN-CONTAINING MATERIALS

The Structure of Dihydrocinerolone. By F. B. LaForge and S. B. Soloway. *J. Amer. Chem. Soc.*, 1947, **69**, 186.

The Synthesis of Dihydrocinerolone. By S. B. Soloway and F. B. LaForge. *J. Amer. Chem. Soc.*, 1947, **69**, 979-980.

The Synthesis and Structure of Tetrahydropyrethrolone. By H. G. Dauben, Jun., and E. Wenkert. *J. Amer. Chem. Soc.*, 1947, **69**, 2074-2075.

Constituents of Pyrethrum Flowers. XX. The Partial Synthesis of Pyrethrins and Cinerins and their Relative Toxicities. By F. B. LaForge and W. F. Barthel. *J. Org. Chem.*, 1947, **12**, 199-202.

Determination of Pyrethrins Deterioration. By W. A. Gersdorff and W. F. Barthel. *Kenya Pyrethrum News*, 1947, **1**, No. 5, 10.

Estimation of Pyrethrins. By H. A. Seil. *Soap*, 1947, **23**, No. 9, 131-133. An account of the Seil method as conducted by him.

Report on Pyrethrum Research at the Imperial College of Science and Technology. By J. Munro. *Kenya Pyrethrum News*, 1947, **1**, No. 4, 16-18. Summary of the report.

Pyrethrum used against Antestia Bug on Coffee. *Kenya Pyrethrum News*, 1947, **1**, No. 8, 15.

Pyrethrum and Diatomite. *Kenya Pyrethrum News*, 1947, **1**, No. 8, 5. Preliminary experiments showed that finely ground pyrethrum mixed with equal weight of diatomite satisfactory on weevil-infested maize.

Contribution à l'Etude de *Volumnus obscurus* Popp., Agent de la " Coulure " des Fleurs de Caféier en Afrique Centrale. By P. Lepesme. *Ann. Epiphyt.*, 1942, No. 8, 47-59. (*R.A.E.*, 1947, **35**, A, Pt. 7, 225-226.) Coffee trees were dusted with a mixture of pyrethrum powder and wood ash to prevent premature dropping off of flowers attacked by this insect.

Ticks and Tick-borne Diseases. Part II. Control Measures. By R. du Toit. *Frmg. S. Afr.*, 1947, **22**, No. 254, 425-431. Pyrethrum spray one of the materials suggested for use against ticks in buildings and other places of concealment.

Diseases of Animals caused by Parasites of the Blood. By M. G. Legereva. *Veterinariya*, 1946, **23**, No. 4, 9-14. (*R.A.E.*, 1947, **15**, B, Pt. 6, 115.) Good control of the mite and ticks of *Rhipicephalus bursa* and *Hyalomma anatolicum* given by dipping in a suspension of pyrethrum powder and arsenic in water.

Treatment of Aeroplanes to Prevent Accidental Transportation of Japanese Beetles. By C. H. Gaddis and L. D. Goodhue. *J. Econ. Ent.*, 1947, **40**, No. 2, 240-244. Tests were made to determine whether aerosols or DDT residues were the most effective; pyrethrum aerosols did not cause complete mortality.

The Formation of Insecticidal Films on Building Materials. II. Tests of the Efficiency of Various Types of Pre-treatment. By P. S. Hewlett and E. A. Parkin. *Ann. App. Biol.*, 1947, **34**, 224-232. Pyrethrum extract was the standard product used.

E. African Pyrethrum. *Chem. Tr. J.*, 1947, **121**, No. 3141, 173. Board of Trade's war-time contract with pyrethrum producers in E. Africa expires at the end of 1947 and producers will be free to dispose of crop on the open market.

Production of Pyrethrum in Japan. *Kenya Pyrethrum News*, 1947, **1**, No. 6, 6, 8.

Pyrethrum Cultivation in Kashmir. By R. N. Chopra, L. D. Kapoor, K. L. Handa and I. C. Chopra. *Indian Frmg.*, 1947, **8**, No. 2, 78-82.

The Cultivation of Pyrethrum in Kenya. Prepared under the aegis of the Pyrethrum Agricultural Research Advisory Committee and published by the Pyrethrum Board of Kenya, 1947.

Pyrethrum (in Nyasaland). *Ann. Rep. Dep. Agric. Nyasaland*, 1945, Pt. I, p. 8. Area in cultivation 30 acres; 3,400 lb. flowers produced in 1945 on the Nyika Plateau.

Some Hints on Transplanting Pyrethrum in the Field. By U. Kroll. *Kenya Pyrethrum News*, 1947, **1**, No. 7, 10-11.

The Spacing of Pyrethrum Plants. By E. W. Gaddum. *Kenya Pyrethrum News*, 1947, **1**, No. 6, 10-11.

Does it Pay to Interplant Pyrethrum? By U. Kroll. *Kenya Pyrethrum News*, 1947, **1**, No. 5, 12.

Some Reflections on the Bud and Flower Disease of Pyrethrum. By E. W. Gaddum. *Kenya Pyrethrum News*, 1947, **1**, No. 4, 15, 17.

A Disease of Pyrethrum in Kenya. By R. M. Nattrass. *Nature*, 1947, **160**, No. 4056, 120-121.

Fertilisers and Pyrethrum. By E. W. Gaddum. *Kenya Pyrethrum News*, 1947, **1**, No. 9, 13-14, 18.

The Correlation between Monthly Rainfall and the Monthly Pick of Pyrethrum. By J. F. Perkins. *Kenya Pyrethrum News*, 1947, **1**, No. 9, 10-11.

Pyrethrum Grading [of Flowers]. *Kenya Pyrethrum News*, 1947, **1**, No. 5, 5.

Pyrethrum and Some Alternative Crops. By J. W. Etherington. *Kenya Pyrethrum News*, 1947, **1**, No. 4, 12.

Newer Synthetic Insecticides. By E. F. Knipling. *Soap*, 1947, **23**, No. 7, 127-131. Refers to compounds used as synergists for pyrethrum.

Stabilised Insecticide. U.S. Pat. No. 2,421,223. *Rev. U.S. Pat. Pest Control, U.S. Dept. Agric.*, 1947, **20**, No. 5, 3. Improved insecticide compositions stable to light, comprising a pyrethrum extract in a hydrocarbon solvent containing from 0.001 to 1.0 per cent. by weight of 2, 4, 6—tritertiary butyl phenol.

Insecticide. U.S. Pat. No. 2,421,570. *Rev. U.S. Pat. Pest Control, U.S. Dep. Agric.*, 1947, **20**, No. 6, 2. Composition containing pyrethrum and α—(3, 4-methylenedioxyphenyl)—tetrahydropyron as a synergist.

Insecticide. U.S. Pat. No. 2,421,569. *Rev. U.S. Pat. Pest Control, U.S. Dep. Agric.*, 1947, **20**, No. 6, 2. Composition containing pyrethrum and 3, 4-methylenedioxybenzyl n-propyl ether as a synergist.

New Synergists. *Science*, 1947, **105**, 530-531. (*Soap*, 1947, **23**, No. 8, 147.) A strong synergist for pyrethrins is (3, 4-methylene-dioxy-6-propyl benzyl) butyl diethylene-glycol ether.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

De Bestrijding van de Hoofdluis met Java-Citronella Olie. By F. E. Loosjes. *Ber. No.* 213, *HandMus. Indisch Inst. Amst.*, 1947. The control of headlice by means of Java citronella oil.

The Constituents of the Bark of *Diospyros maritima* Bl. By T. M. Meijer. *Rec. Trav. Chim.*, 1947, **66**, 193-198.

The Insecticidal Component of *Eugenia haitiensis* identified as 1 : 8—Cineol. By M. Jacobson and H. L. Hallar. *J. Amer. Chem. Soc.*, 1947, **69**, 709-710.

Control of Lygus Bugs on Alfalfa Seed Crops with DDT and Sabadilla. By A. E. Michelbacher, R. F. Smith and N. L. McFarlane. *Circ. No.* 365, *Calif. Agric. Exp. Sta.*, pp. 7-18. (*Amer. Chem. Absts.*, 1947, **41**, No. 9, 2846.) Fields treated with sabadilla gave a higher yield than control plots : sabadilla had a harmful effect on bees ; it had little residual action.

Tests of Sabadilla for Controlling the Green Stinkbug on Peaches. By N. W. Frazier. *Circ. No.* 365, *Calif. Agric. Exp. Sta.*, p. 93. (*Amer. Chem. Absts.*, 1947, **41**, No. 9, 2848.) Sabadilla effectively controlled *Acrosternum hilaris*.

Insecticides. U.S. Pat. No. 2,423,284. *Rev. U.S. Pat. Pest Control, U.S. Dep. Agric.*, 1947, **20**, No. 7, 2. Mixture of capsicum and sabadilla seed with calcium salts as activators.

Control of Certain Cotton Insects with DDT and Sabadilla. By G. L. Smith. *Circ. No.* 365, *Calif. Agric. Exp. Sta.*, pp. 30-33. (*Amer. Chem. Absts.*, 1947, **41**, No. 9, 2847.) When sabadilla-sulphur dusts were applied to cotton greater yields of seed cotton were obtained from treated plots than untreated plots.

MINERAL RESOURCES

ARTICLE

THE GEOLOGY AND MINERAL RESOURCES OF TANGANYIKA TERRITORY

By G. M. Stockley, A.R.C.S., D.I.C, Assoc.Inst.M.M., F.G.S.
Chief Geologist, Geological Division, Department of Lands and Mines, Tanganyika Territory

The territory of Tanganyika lies entirely within the tropics, between latitudes 1° and 11½° south, bordering Uganda and Kenya on the north and Nyasaland and Portuguese East Africa on the south. To the east, the ocean front provides a coast line along the Indian Ocean of some 500 miles; to the west, the frontier adjoins the Belgian Congo and Northern Rhodesia. The whole Territory thus enclosed comprises an area of 360,000 sq. miles, of which 20,000 sq. miles includes country covered by the three Central African Lakes. Tanganyika has within its borders the highest mountain in Africa, Kilimanjaro, 19,565 ft. high; on its western boundary occurs the world's second deepest lake, Lake Tanganyika, attaining a maximum depth of 4,834 ft. (or 2,300 ft. below sea-level) and a length of 450 miles; and in the Serengeti Plains there is one of the richest wild game sanctuaries in the world.

The chief economic minerals of Tanganyika, previous to the British occupation of the country in 1918, were mica, gold, garnet, coal, iron ore, uranium minerals, copal, trona, and salt. Of these minerals mica, gold and garnet were exported to Germany; most of the copal was exported to Zanzibar and England. At that time mica was known from the Uluguru Mountains, Bagamoyo District, Usambara Mountains and from Lindi District. Gold was worked in a small way in the Singida, Musoma, Mwanza, Kahama and Shinyanga districts. Copal was worked at many localities on the coastal plain and near the coast, especially in the Southern Province. Common salt was obtained from the salt springs near Uvinza and by evaporation of sea water in shallow "salines" along the coast. It is difficult to estimate the value of annual mineral production prior to 1918, but it seems not to have exceeded £100,000.

The mineral wealth of Tanganyika is still unknown; indeed, only about one-tenth of the country is known in any detail to the geologist and prospector. Mining is still in its infancy; at the moment there is scarcely a mine in operation that is 20 years old.

The oldest and deepest mine, at Sekenke in Singida District, which stopped working owing to lack of adequate pumps early in 1942, had been operating off and on for over 35 years, and was for many years the chief mine of any importance. Its place as a gold producer has now been taken by Geita, Saza, Buhemba and North Mara. Notwithstanding the still unexplored state of the Territory, the annual value of mineral production during the short period of British rule has multiplied 16 times, and the number of minerals known to exist in economic quantities is increasing annually.

Main Natural Features

Communications by road or rail are materially influenced by the disposition of the scarps and highlands. The scarps, which were formed by the dislocation of the highly peneplaned (Miocene) surface of Africa, cross the Territory, trending mainly north-north-west to north-west or north-north-east to north-east. As the traveller leaves the east coast and penetrates inland he climbs successively from sea-level to 1,000-1,500 ft. near Morogoro, and from 3,000 to 4,500 ft. on to the Central Plateau region. The Central Plateau is disrupted by the two great Rift troughs—*the Gregory Rift,* stretching right across the country from near Lake Natron, north-west of Kilimanjaro, to a focal point north of Lake Nyasa, and *the Western Rift,* extending from this focal point north-westwards *via* the Rukwa Trough to Lake Tanganyika. At the focal point, near Mbeya, masses of volcanic material have broken through and erupted to form Rungwe Mountain. The Gregory Rift is also marked by volcanic masses that have penetrated the earth's crust and overflowed on to it in and adjacent to the Rift, the most striking of which include the ancient volcanoes of Hanang, Ufiome, Meru, Kilimanjaro, Ketumbaine, Ngorongoro, and the still active volcano Oldoinyo Lengai.

To the east of the Gregory Rift a number of mountain blocks interrupt the almost featureless peneplaned surface; the more important are the Pare and Usambara blocks in the north-east, the Nguru, Kaguru, Chenene, and Uluguru blocks in the central region, and the Mahenge, Ukinga-Upangwa, and Matengo blocks in the south and south-west.

Geomorphological History

A consideration of the long chain of events that has produced the existing land forms of the Territory opens up many debatable questions, many of which involve correlation and discussion of the palaeogeography of Africa as a whole, and of Central and East Equatorial Africa in particular.

It will be sufficient here to start with post-Karroo or late Mesozoic times, when the long-continued and widespread sedimentation, chiefly in continental lake basins, came to a close and a new era of igneous and tectonic activity was ushered in. The Karroo

basins of the coastal region became partially, if not entirely, submerged over a distance at least 90 miles from the present coast line, until late Tertiary times when steady and continued uplift succeeded. The recent period was marked by slight oscillations, the most important being a marginal drowning which has formed the useful harbours of Tanga, Dar es Salaam, Kilwa, Mikindani and other similar inlets along the coast.

In the interior of the Territory there are no post-Karroo fossiliferous sediments of proved age older than Pleistocene. There is, therefore, an enormous hiatus in the geological record. Deposits in Nyasaland, Kenya, and Uganda carry one back a little further, certainly to Pliocene, probably to Miocene, and perhaps in Nyasaland to late Cretaceous. Apart from this evidence, one is driven back to consider morphological features.

While the coastal regions were being downwarped in Jurassic and Cretaceous times, there was probably a wide continental upwarping of the inland region accompanied by some block-faulting which let down parts of the Karroo strata into the ancient Basement on which they had been deposited. Peneplanation continued to an advanced stage, removing most of the remaining Karroo deposits. Relics are preserved as ridges and dissected blocks rising from 800 to 1,000 ft. above a much more perfectly preserved peneplain, which in the least disturbed region of the central section lies at a present altitude of 3,500 to 4,000 ft. This younger peneplain was the result of renewed uplift with a period of widespread stability in what was probably Miocene time.

Slight warping, forming shallow basins, introduced a period of increasing tectonic activity which began to lay out the main lines of our present topography. Probably the drainage was of a normal continental type with an uninterrupted though sinuous Atlantic-Indian Ocean divide, situated along what is now the site of the Central Rift Zone. As tectonic disturbances became more intense, the upwarping of the eastern and western highlands with wide shallow downwarping of the great central region developed, and the troughs of the western lake zone began to make their appearance. Volcanic eruptions, which had previously broken out in several widely separated regions and then suffered a period of quiescence, began to renew their activities round or near the old centres. Troughs deepened, highlands continued to rise, and the old drainage systems were seriously interfered with. The original Rukwa and Eyasi dischargeless basins had already captured much of the oceanic drainage, which they still hold; while drowning of topography started in the Lake Victoria region. Moreover, a large shallow lake was probably formed over the site of the Malagarasi swamps, which may have had a connection through to Lake Victoria and thence to the Nile for a time, though this is not certain.

The first pluvial period of Pleistocene times provided water that filled troughs and basins, some of which overflowed and re-established

connection with oceanic drainage, as in the case of the Ruaha to the Indian Ocean and the Malagarasi swamps to Lake Tanganyika and the Congo and Atlantic. Then followed a succession of alternately dry and wet cycles with the final result that all the great inland sheets of water reached their present level. In places, notably the Rukwa, Ruaha, Wembere, Eyasi, Oldoway, and Manyara basins, the old lake strata record striking evidence of the Pleistocene climatic changes. The present local base levels have had a marked influence on the adjacent topography by the active rejuvenation of stream activity which has advanced into the older levels to a degree varying with the resistance offered by the various formations, although even in the softest it is of striking youthfulness.

One of the latest episodes is renewed tectonic disturbance along the Central Rift Zone, where faulting with a throw of some hundreds of feet has dislocated the very youngest of the Pleistocene lake deposits and young ash beds. Frequent tremors along both the western and eastern zones indicate that adjustments are still proceeding. The existence of lake basins, dislocated topography, and disturbed river systems, as well as the unadjusted character of the topography generally, provides striking evidence of the persistence of tectonic activities until the present time. (After E. O. T.[1])

Geology

Tanganyika is favoured by a variety of geological formations, each of which is remarkable for its peculiar interest. About 45 per cent. of the Territory is occupied by the oldest, the Basement System; about 25 per cent. comprises the Granitoid Shield; 6 per cent. the Nyanzian, Kavirondian and Muva-Ankolean; Bukoban about 6 per cent.; Karroo about 8 per cent.; Post-Karroo Sediments 7 per cent.; and Rift Valley Volcanics 3 per cent. Mineral deposits are definitely related to the geological formations, as will be seen from the tabulated statement on p. 379.

Exposures are on the whole numerous, though much of the country is overlaid by residual deposits (sands and sandy clays from granitic rocks and sandstones, red and yellowish loams and loamy clays from intermediate and basic igneous and metamorphic rocks, reddish and blackish clays from crystalline limestones), by laterite and superficial terrestrial sandstones or chertified deposits, and by lacustrine muds and sands of small dischargeless basins. The best exposures are naturally on the main scarps and in the stream courses and drainage ways.

Fossiliferous rocks are limited to Karroo and post-Karroo sediments. The most important fossils so far discovered are the Permian and Triassic (Karroo) reptiles of the Ruhuhu basin and the Lower Cretaceous dinosaurs of Tendaguru, west of Kilwa. At Kidodi, south of Kilosa, the Karroo sediments yield both lacustrine

[1] E. O. Teale, past Director of the Geological Survey of Tanganyika Territory.

TANGANYIKA TERRITORY: TABLE OF FORMATIONS

GROUP.	SYSTEM AND FORMATION.	MORE IMPORTANT ECONOMIC MINERALS AND ROCKS. Principal deposits which have been and are being worked (excepting building materials) shown in heavy type.	MAIN INTRUSIVE ROCKS.
KAINOZOIC	RECENT TO TERTIARY — *Marine*	Building stones. Limestone, clays and sands.	
	Superficial and Lacustrine	**Diamonds,** alluvial and eluvial **gold.** Mbuga limestone, kunkar. Diatomite, clays and sands. Gypsum.	(Decomposition of granitic rocks yielding kaolin; completed end of Miocene peneplanation.)
	Kilimatinde Cement	**Salt.**	
	TERTIARY *Marine*	Limestones, clays, sands.	
	RIFT VALLEY VOLCANICS	Pozzolanas, red **ochre,** road metal. *unconformity*	7. *Tertiary dykes* connected with Rift Valley volcanicity: road metal.
MESOZOIC	CRETACEOUS	Limestones, clays, sandstones. Building stones, **kaolin** (Pugu).	6. *Late Cretaceous Kimberlites*: diamonds.
	JURASSIC	Sandstones, limestones, clays. *unconformity*	
PALAEOZOIC	KARROO	Coal, paving and building stones, some fireclays, some limestones. *unconformity*	5. *Karroo and post-Karroo dolerites*: road metal.
	BUKOBAN	Building stones, dolomitic limestones, quartz crystals from sandstones. *major unconformity*	4. *Post-Bukoban gabbro-norite-serpentine etc., suite*: platinum, chromite, titaniferous magnetite.
EOZOIC	MUVA-ANKOLEAN	**Tin, tungsten.**	3. *Post-Muva-Ankolean granite*: tin and tungsten.
ARCHAEOZOIC OR PRIMITIVE	KAVIRONDIAN	Some **gold.** *unconformity*	2. *Post-Kavirondian granite*: gold.
	NYANZIAN GRANITOID SHIELD	**Gold,** lead (some copper). Little **gold.**	1. *Post-Basement Granite*: gold, lead, copper, and tungsten. *Post-Basement Ultrabasics*: nickeliferous magnetite, chromite, magnesite, soapstone.
	BASEMENT	Nickeliferous magnetite, chromite, magnesite, soapstone (talc), **mica,** corundum, graphite, dolomitic limestone, apatite (phosphate), limestones, kyanite, little **gold** and optical quartz.	NOTE.—1, 2 and 3 may be different intrusives at successive ages or may be contemporaneous. Dolerites post 1, 2, 3 or 4 suitable for road metal.

and marine mollusca at several horizons. Along the coast in the vicinity of Lindi and Kilwa palaeogene rocks are replete with foraminifera, mollusca and echinoidea.

Basement System

The oldest formations are those of the Archaean or, in East African terminology, *Basement System*, which occupy about one-half of the surface area of the Territory. They consist largely of a complex group of highly metamorphic crystalline sedimentary rocks and some basic igneous rocks. The chief characteristic exhibited by these rocks is the uniform high grade hypo-zone metamorphism with extensive metasomatism resulting in a series of migmatites, biotite-gneisses and gneissose granites. In particular they commonly include a peculiar mineral suite, garnet, kyanite, pyroxene, amphibole and scapolite. This degree of metamorphism never varies, whether near to or far from the Granitoid Shield or mobilised granite bodies ; at every locality stretching over hundreds of miles of country their coarse crystalline nature remains unchanged.

The key to the understanding of these rocks, it is believed, is the conception of the granitization of an original series of sediments. They may be divided into four main groups :

4. Metacalcareous and Psammitic Beds.
3. Graphitic Beds.
2. Mixed gneisses and granulites with hornblende, biotite, kyanite and garnet.
1. Charnockites, metadolerites and a variety of basic and ultrabasic rocks.

The relative ages of these main types are not yet worked out, though on general geological grounds the Metacalcareous and Psammitic Beds and the Graphitic Beds are considered the youngest. The origin of the Charnockites is still a matter of controversy ; a great variety of hypersthene-bearing rocks is already recognised from many parts of the Territory. Within the areas of the Basement Complex ultrabasic intrusives are often found, and in these bodies deposits of chromite, nickeliferous magnetite and nepouite (nickel-bearing chlorite), magnesite and corundum are known. In the metacalcareous rocks, graphite and dolomitic limestone extensively occur. Apatite-bearing zones within the limestone are known from two localities.

Cutting through most of these formations are a number of mica-pegmatites. It seems likely that the great majority of these pegmatites is restricted to the areas of the older gneisses and schists ; they have not been reported as yet from areas of metacalcareous and graphitic beds and there may be some significance in this distribution.

Mica is the most important mineral so far worked ; other minerals are garnet, ochre, soapstone, corundum, and to a less extent dolomitic limestone. Some alluvial gold was won from the

Ruvu River and Mtombozi Stream in the Eastern Ulugurus. Placer gold has also been worked in a number of streams of the Southern Province.

Granitoid Shield

These rocks, comprising migmatites, biotite-gneisses, gneissose granites and local masses of mobilised biotite-granites, are considered to be the end-products of granitization of the sediments of the Basement System. They occupy large portions of the High Plateau region of Tanganyika. Small deposits of reef and placer gold are known from these rocks.

Nyanzian System

The Nyanzian System is subdivided into four definite series: Kuria volcanics, acid and basic volcanics with their tuffs and agglomerates, and the Banded Ironstone suite, *i.e.*:

4. Kuria Volcanics.
3. Banded Ironstone Suite.
2. Acid Volcanics.
1. Basic Volcanics.

The stratigraphy of the Nyanzian is exemplified by the geology of the area south of Lake Victoria, through Musoma District to Kavirondo on the northern shore of the lake (Kakamega). In the southern area around Kahama there are more ashes and tuffs than volcanic rocks, whereas in the region of Musoma District, from Mrangi to the sub-district of North Mara, tuffaceous sediments are subordinate to the rhyolites, spherulitic rhyolites and trachytes. In the intervening region of the Serengeti Game Reserve these rocks are represented by a thick series of banded ironstones, argillites (? tuffs), grits and phyllites. To the north, in the Banagi-Ikoma area, there are pillow lavas, andesites, and trachytes, which may be correlated with the Basic Volcanics.

Low-grade metamorphic changes are common to all areas, but in the Mrangi-Buhemba belt of Musoma District shearing and carbonation are dominant. In this belt slabby masses of grey-green rocks are common; thin slices prove them to be sheared and carbonated acid and trachytic volcanics. They are appropriately named the *Tombstone Formation*. The Tombstone Formation frequently contains auriferous-quartz veins, and it is often difficult to identify in the field with the same exactitude as the other rocks of the Nyanzian.

The Nyanzian is the principal formation for locating gold reefs and impregnations; indeed, the Victoria Nyanza region is one of the most important gold mining regions of East Africa.

Kavirondian System

Stretching from Speke Gulf near Geita Mine through south-west Mwanza District into Musoma and Mara Districts is a number

of outliers of massive boulder conglomerates overlying the Nyanzian and containing pebbles and boulders of banded ironstone, Kuria volcanics, and granites etc. In North Mara the outcrop is extensive and similar exposures have been noted by Kenya geologists in Southern Kavirondo. In North and Central Kavirondo the boulder conglomerate passes into argillaceous types with quartzites, arkoses and grits associated with conglomerates. This succession in Northern Kavirondo is more complete and must be more typical than the Tanganyika representatives.

The conglomerates are cut by granites, quartz reefs (some of which are auriferous) and other apophyses, and thus are pre-Bukoban in age. But there still remains some doubt as to whether the Kavirondian may be correlated with the Muva-Ankolean. Geologists both in Kenya and Uganda consider there is a distinct possibility that the Kavirondian changes from the conglomerates to an argillaceous facies and thus into typical Muva-Ankolean. On the other hand, the Kavirondian is commonly infolded within the Nyanzian and seems to be directly related to it.

Muva-Ankolean System

The Karagwe Highlands are composed of ancient unfossiliferous sedimentary rocks termed the Muva-Ankolean System. These rocks consist of quartzites with occasional lenses of conglomerates, phyllites, shales and mudstones. No estimate of their total thickness can be given, because neither the base nor the top of the System is visible in Karagwe. The System comprises:

	Thickness. *ft.*
Kishanda Beds	6,700
Mtagata Quartzites	4,900
Mabira Beds	20,500
Kafulu Quartzite	5,800
Arena Beds	5,000
Maximum total	42,900

No base exposed in Karagwe.

In general it may be stated that two distinct quartzites, separated by shales and phyllitic shales, have been recognised and named the Mtagata and Kafulu Quartzites. Owing to the folding and general disturbance of these strata it is not possible to calculate with any degree of accuracy the thickness of the intervening pelitic sediments. Mapping has shown that there are some 6,700 ft. of pelitic sediments above the Mtagata Quartzite, but only an approximate computation of the thickness of the rocks underlying the Kafulu Quartzite is possible.

The Muva-Ankolean of Karagwe were intruded by granite cupolas, which invasion followed the buckling of the strata into steeply folded synclines and anticlines. The immediately peripheral

rocks were metamorphosed to schists, phyllites and andalusite-bearing rocks, and a part of this aureole was metasomatized into tourmaline-schists. The intense folding, pene-contemporaneous with the emplacement, caused the local development of ottrelite-schists.

A number of cassiterite-bearing mica-quartz veins occur in areas of low-relief, locally termed "arenas." These veins are found within the tourmalinized aureole and also the granite peripheral area, and they have often given rise, through erosion, to many valuable eluvial cassiterite-rich deposits. Tungsten was also located and worked in the Ibanda Arena within a small granite outcrop—the summit of a granite cupola peeping through the eroded cover of the Muva-Ankolean Arena Beds.

The Muva-Ankolean of Karagwe continue southwards into the western Biharamulo District and westwards into the Belgian Congo; the southern extension, however, has not been examined to any extent, though cassiterite is reported from Bugufi.

A Muva-Ankolean quartzite bed occurs north of Kigoma, on the shores of Lake Tanganyika, but it has not proved to have any economic significance.

Bukoban System

Separating the older rocks and the granites from the youngest unfossiliferous sediments there is a great unconformity, which probably represents a vast interval of geological time. The granites which had invaded all the previous formations were so denuded previous to the deposition of these sediments that for considerable areas the granite formed the floor on which the sediments were deposited. There is strong evidence for a fossil peneplain, forming the sub-Bukoban surface.

The writer correlates the Bukoba Sandstones with a part of Teale's original Uha System. The name Bukoban assigned to a system is in this case unfortunate, because few details are known about it. No succession has been determined and the stratigraphic position is a little vague. Teale, in the *Lexicon de Stratigraphie* (Africa), describes the formation as follows:

> "A. D. Combe, 1926 (Geological Survey, Uganda, Annual Report for 1925, pp. 14-20). Formation consisting dominantly of fine to medium-grained, compact white unfossiliferous sandstone, with interbedded quartzitic types and fine compact shale-like argillaceous sandstones. Thickness approximately several thousand feet. Beds are very slightly folded and show only low angles of dip . . . Regarded as younger than the Karagwe-Ankolean sediments to the west."

Within the sandstones, Groves found detrital tourmaline and cassiterite in the heavy mineral residues. This fact supports the suggestion that these rocks are post-Muva-Ankolean, but the base and the sequence are unknown.

Teale, on the other hand, has worked out the main data for the Uha System, which is now regarded as being equivalent to the Bukoban. The age of the Uha System has been a matter of doubt; it has been considered either of Karroo or of Bukoban age. At the meeting of the Conference of African Geological Surveys (1931), held at Kigoma, the discussion on this formation showed that the consensus of opinion was against a Karroo age. The matter turned on the presence of some pseudo-plant remains and certain calcareous algae resembling *Collenia*. These calcareous algae were examined by palaeontologists, who identified them as *Cryptozoon* and *Archaeozoon*, which have a time range from pre-Cambrian to Permian, and therefore are of little value as an index to age. It is also doubtful if the so-called plant impressions are organic at all, a doubt which was expressed by the late Professor Salée.

The rocks of this System comprise:

			Thickness. ft.
Uha System	5.	Red Beds	2,000
	4.	Dolomitic Limestones with cherts and inter-bedded shales at base	500
	3.	Basaltic Lavas	? 2,000
	2.	Malagarasi Sandstone and Quartzites	1,500
	1.	Dark to olive Shales	

That Teale himself was not convinced of the Karroo age of the Uha System may be gained from a perusal of the proceedings of the Kigoma Conference, for he actually agreed with Professor Salée, when he suggested that these rocks should be correlated with the Katanga System.

De la Vallée Poussin (Manager, Uruwira Minerals, Ltd.), the late N. W. Eades (late member of the Tanganyika Geological Survey), and the writer have seen and studied in the field the Uruwira Quartzites and Sandstones, which are an extension of the Malagarasi Sandstones and Quartzites, and they are of the opinion that these rocks should be correlated with the Bukoban.

Further, similar rocks from other parts of East Africa fall into line with those of the type area of Uha. In Buanji, the lower beds of chocolate-coloured shales and flags, black grits, and massive quartzitic sandstones, quartzites and grits are cut by a fault, so that there lacks a continuous section, but they may be correlated with beds 1 and 2 of the Uha System. The upper Buanji Series includes red shales with bands of quartzite and sandstones, a dolomitic limestone, more red shales with quartzite bands, a lens of conglomerate, more reddish shale with grits, overlain by silicified and dolomitic limestone and 700 ft. of amygdaloidal lava. The Uha System comprises dark to olive shales at the base, overlain by the Malagarasi Sandstones, basaltic lavas, a dolomitic limestone with cherts and interbedded shales at the base, overlain by Red Beds. In Kenya, the Kisii Series include (1) basalts, (2) quartzites, and (3) andesites. In Ikorongo and the Ikoma-Serengeti area of eastern

Musoma District there are no volcanic rocks, and the sequence in the north-east suggests a three-fold division of quartzites and shales at the base, a middle series of sandstones and greenish shales, and an upper of quartzitic sandstones : the succession in the south-east comprises green greywackes, white grits, and conglomerates at the base, overlain by purple quartzites and green and olive-coloured shales and sandstones.

In stratigraphic position, in lithology and general succession, and in the lack of index fossils, the Uha System may be correlated with those rocks that have been called Bukoban.

Karroo System

If the *Collenias* and other alleged calcareous algae of the Bukoban System are disregarded, the Karroo System is the oldest fossiliferous formation in the Territory. Following the deposition of the Bukoban there was an extensive period of denudation prior to the warping of the earth's crust which heralded the origin of the great basins of sedimentation of the Karroo Era. Between these basins there must have been ranges of hills to provide the masses of sediment, which comprise the strata of the Karroo rocks. The main areas of Karroo rocks are depicted on the geological map in a Y-shaped figure, the left arm coinciding with the Rukwa-Nyasa Rift and the right arm with the Tanga-Rufiji-Mbarangandu region. The largest single area of Karroo rocks is the extensive plateau country between the Rovuma and the Rufiji rivers. Most of the other areas lie close to the Western Rift Valley. They may be enumerated as follows, commencing from the north-west, following the Western Rift Valley to Lake Nyasa (1-6), and then following from Tanga, in the north, south-westwards to Lake Nyasa (7-13).

1. Ifume Conglomerate.
2. Manyoro-Usevia outcrops.
3. Namwele-Mkomolo Coalfield.
4. Muze Coalfield.
5. Galula Coalfield.
6. Kivira-Songwe Coalfield.
7. Western Tanga Karroo, including Pangani.
8. Between Central Railway and Rufiji-Ruaha Rivers.
9. Kidodi-Ruhembe Valley, south of Kilosa.
10. Rufiji-Ruvuma River, including Muhukulu Coalfield.
11. Ruhuhu Coalfields basin.
12. Njuga Coalfield.
13. Mbamba Bay Coalfield.

In general, basal conglomerates overlie unconformably the older rocks, and these are succeeded by sandstones, carbonaceous and grey shales locally with coal seams and marls with some limestones. The uppermost beds are usually massive sandstones overlain by alternate marls and sandstones. An unconformity occurs within the Triassic, a series of soft sandstones with pebble beds and marls

cover extensive regions of the Southern Province, overlying both rocks of the Basement System and younger Karroo.

The Karroo succession (K_1 to K_9) in Tanganyika is based on the sequence worked out in Songea and Tunduru districts in the Southern Province, where fossiliferous horizons have proved the correlation with the already established South African stratigraphy.

TRIASSIC

K_9 Tunduru Beds with *Scaphonyx* spp. 2,000 ft.

Unconformity.

K_8 Manda Beds containing Anomodonts, Labyrinthodonts, Theropods and Thecodonts; also freshwater mollusca *Unio karooensis*. 440 ft.

K_7 Kingori Sandstones with Anomodonts. 1,200 ft.

(*Local disconformity*.)

PERMIAN

K_6 Lower Bone Horizon (*Endothiodon-Cistecephalus*) zone containing species of *Dicynodon*, *Endothiodon*, *Pachytegos*, *Anthodon* and *Megacyclops*. 300 ft.

K_5 Ruhuhu Beds containing *Palaeomutela* spp., *Glossopteris* spp., and *Gangamopteris* sp. ? 700-1,000 ft.

K_4 Upper Coal Measures. 335 ft.

K_3 Intermediate sandstones and marls. 450 ft.

K_2 Lower Coal Measures. 450 ft.

K_1 Basal Sandstones and Conglomerates. 1,690 ft.

In the Karroo rocks of the Kidodi region, south of Kilosa, a comparable succession was worked out, but no reptilian bones were found. The palaeontology is dependent on the presence of both freshwater and marine mollusca, and a parallelism is possible with the Madagascan sequence where type cephalopods have determined the relative ages of the beds. The Kidodi Series are divided as follows:

K_8-K_7 Ruhembe Beds with *Gervillia* spp., *Myalina* sp., *Liebea* sp., *Modiolopsis* spp. and a *Pteria*; also *Palaeanodonta* spp. and *Carbonicola* spp. 3,700 ft.

K_6-K_5 Calcareous Beds with species of *Kidodia*, *Palaeanodonta* and *Palaeomutela*; also the fish *Colobodus africanus* and the plants *Glossopteris* spp. 700-800 ft.

K_4-K_1 Ndeke Beds. 2,900 ft.

At Tanga a small reptile, *Tangasaurus menelli*, was found, and in the Rufiji-Ruaha Karroo area both fish and numerous plants are known. In the large area of soft Upper Triassic sandstones of the Luwegu-Mbarangandu drainage, large fossil silicified trees (*Dadoxylon*) are not uncommon.

A more detailed description of the coal seams and their distribution is given in a later section.

Jurassic System

The close of the Karroo sedimentation, characterised largely by continental conditions of deposition, was marked by an extensive marine transgression westward of the present coastal line, amounting in places, at least, to as much as 100 miles. Jurassic sediments are better developed in Tanganyika than elsewhere in East Africa.

They are found inland from Tanga with good fossiliferous exposures, notably in the Mkulumizi Valley, and the beds are traceable southwards nearly as far as Lindi. They have been uplifted to over 1,000 ft. above sea-level, faulted, and tilted seaward usually at gentle angles.

The rocks include pisolitic, oolitic, and ordinary fossiliferous limestone, as well as calcareous sandstone and marl. Such rocks are well exposed on the Central Railway in the neighbourhood of Kidugallo.

Inland, between Kilwa and Lindi, there are frequent outcrops associated with the overlying Cretaceous formation. In this region occur the famous Tendaguru Beds, noted for the large and abundant saurian remains they have yielded, including *Gigantosaurus africanus* claimed to be the largest extinct reptile yet discovered. The characters of this formation are essentially arenaceous; it consists of deposits laid down under alternating marine and estuarine conditions and estimated to be about 1,000 ft. in thickness. Coarse pebbly sandstone forms part of the *Smeei* Beds, while fine sandstone, siltstone, and sandy clays, often well laminated and occasionally reddish or greenish-grey with a tendency to spheroidal jointing, may be taken as typical of almost any other part of the series. The beds are commonly calcareous, but limestones are absent.

Dietrich has proposed a modified classification of the original one as follows:

Schwarzi Beds	Neocomian.
Upper Saurian Bed	Purbeck-Portland.
Smeei Bed	Portland-Kimmeridge.
Middle Saurian Bed	Kimmeridge.
Nerinea Bed	Kimmeridge-Oxford.
Lower Saurian Bed	Kelloway.

The German claim that the formation represents a continuous series from Jurassic to Cretaceous has been strongly criticised by Dr. Kitchin, and he has advanced arguments in favour of placing the *Trigonia Smeei* Bed in the Neocomian; in fact he points out that the whole evidence for Jurassic of any portion is slender, and he is more in favour of a correlation with the Lower Cretaceous of South Africa and the Cutch of India.

Well exposed sections of the normal Jurassic occur along the Central Railway between Ruvu and Ngerengere, especially between Km. 116 and Km. 140. The deposits of the Mkulumizi Valley near Tanga, those inland from Bagamoyo, and those at Mahokondo near Kiswere, have also yielded good collections of fossils from Bathonian to Kimmeridgian. (After E. O. T.)

Cretaceous System

This period was marked in Tanganyika by a retreat of the sea to some extent, and it is chiefly in the south-east portion of the coastal region that the Cretaceous deposits have been most prolific of fossil remains.

The Lower Cretaceous is well represented between Kilwa and the Ruvuma on the Nondo, Noto and Makonde plateaux. The deposits are of two types: (*a*) extensive unfossiliferous sandstones including the Makonde Beds and Newala Sandstone, which probably represent, in part at any rate, continental conditions of deposition; (*b*) marine fossiliferous deposits of two horizons. Of the two horizons of (*b*), Aptian coral limestones occur in the Kiturika Hills, west of Kilwa, rising to about 1,000 ft. above sea-level. Also, in the Mahokondo and Likondo, inland from Kiswere, a Neocomian horizon is represented by the *Trigonia schwarzi* Beds intercalated with the saurian beds in the Tendaguru region.

Upper Cretaceous beds are much more limited in extent and occur in Usaramo, where they consist of marl with limestone intercalates and the greyish-brown Usaramo Sandstone. The white kaolin-sandstones of Pugu probably belong to this period, and near Kigua, some 25 miles west of Bagamoyo, are flat-lying, yellowish-red, micaceous and calcareous sandstones and clays, which have yielded a few Upper Cretaceous (Cenomanian) fossils. (After E. O. T.)

Tertiary to Recent Formations

Marine and Estuarine Deposits

The marine deposits of this period are restricted to a narrow strip along the coast. These strata are much more calcareous in character than the preceding Cretaceous beds. The deposits near Lindi have been subdivided by Stockley on the basis of foraminiferal identifications by Dr. A. Morley Davies:

5.	*Wanyamwao Beds* (Burdigalian) with Amusiopectens, etc.	LOWER MIOCENE.
4.	*Mambi Beds* (Aquitanian) with *Lepidocyclina* (*Eulepidina*) *dilatata*, etc. . . .	
3.	*Kitule Beds* rich in echinolampids . .	OLIGOCENE.
2.	*Kitunda Beds* with *Nummulites brongiarti*, *N. aturicus*, *N. aff. beaumonti*, *Discocyclina* sp.	MIDDLE EOCENE.
1.	*Lindi Beds* with *Alveolina subpyrenaica* and *Nummulites mammilla* . . .	LOWER EOCENE.

At Dar es Salaam a 530-ft. borehole showed an alternation of marine and estuarine sands, clay and some coral limestone; the lowest of these sediments yielded shells thought by Wolff to indicate Pliocene but regarded by Krenkel as Pleistocene.

Recent work along the coast between Tanga and Pangani has shown on palaeontological evidence that the Pliocene rocks may extend southwards to Pangani.

The Mikindani Beds consist of reddish sands, loams, grits, sandy ferruginous clays, and pebble beds of some considerable extent in the coastal hinterland, commonly attaining a thickness of over 100 ft. They have been correlated with the Masingini Beds of Zanzibar and the Magarini Sands of Kenya. The latest formations

along the coast include estuarine silts, sandstones, raised and living coral reefs, all of which are Pleistocene to Recent.

Freshwater and Surface Deposits

Of the inland Kainozoic to Recent deposits, nothing definitely older than Pleistocene has yet been proved. Their study is of importance in regard to the latest chapters in the physiographical history of the existing land surface. Worthy of special mention are the important and highly fossiliferous lake-beds of Oldoway (Olduvai), investigated by Reck and Leakey, which may be likened to a fossil African zoo—so great a variety of animal life (including man and his implements) has there been found.

Although a more conservative estimate regarding the antiquity of the human remains found on this site is now generally accepted, there can be no doubt of their great antiquity, and that the Oldoway Beds antedate some of the latest vulcanicity and faulting of the Rift period. Their age is considered to be lower and middle Pleistocene.

The Tinde Bone Beds which form part of the extensive lake-beds of the Manyongo Basin, and the leaf-bearing lake-beds of Rukwa and Iramba indicate considerable geographical changes even in the latest chapter of the geological history of this region.

The surface deposits, though not possessing very great thickness, are nevertheless of considerable importance owing to the extent of the area covered by them and to their influence on agricultural, pastoral and mining conditions. They consist of clays, sands and sandy clays of a more or less unconsolidated character; and in addition there are important hard crusts (duricrust) of consolidated material, such as "cement," tufa, silcrete, as well as ferruginous crusts in part lateritic. Many of these deposits are found typically in existing peneplain regions, or as relics on plateau or highland areas, where denudation has not had time to destroy them completely.

Of the first group, the sandy and heavy black clays of depressions or "pans," locally called *mbugas* (=*dambos* of Rhodesia), enter mostly into problems relating to roads as well as to agricultural, pastoral and prospecting conditions. Many of the areas covered by deposits of this kind represent swamps or shallow lakes of an earlier and moister period. The "cement" is a special type of material composed chiefly of partly redistributed granitic detritus cemented usually by fine clay, or less commonly by lime or silica. In general it resembles somewhat recemented eluvial decay from granite, but it also shows typically some transportation and sorting. It is, perhaps, more in the nature of recemented fan-detritus. The calcareous crusts are found in arid and sub-arid regions overlying limestone of various kinds, or else crystalline rocks rich in lime-silicate minerals, especially the richly hornblendic varieties.

The ferruginous crusts, in the main lateritic, but also in some cases old swamp deposits, are found in areas of present low relief

(or such as were recently so) with a rainfall still markedly seasonal, but of greater amount and better distribution than that of the more arid parts of the country, where such deposits are notably rare or absent.

The Rift Period of Volcanic Activity

No account of the geology of the Territory would be complete without reference to the important volcanic disturbances of great magnitude that have occurred at intervals during the Rift period. The date of the first eruptions is not fixed, but in some parts of East Africa, it would appear to go back into the Cretaceous. The most important volcanic activity, however, is confined to parts of the Tertiary and Quaternary with considerable intervals of quiescence. Oldoinyo Lengai, still occasionally active, is a survival of this important period of vulcanicity. The characteristic feature of the rocks is the predominance of alkaline types, ranging from acidic to ultrabasic in composition. Thus, the suite includes soda-bearing rhyolites and trachytes, phonolites, kenytes, olivine-basalts, basanites, tephrites, nephelinites, augitites and limburgites, together with a number of interesting varieties of the above main types.

The largest and most important volcanic area is the northern one, which includes the region of the giant craters (Ngorongoro), a portion of the Serengeti Plains, and the country around Arusha and Moshi, where there are many prominent volcanic peaks rising to upwards of 10,000 ft. above sea-level. A smaller but powerful volcanic focus is situated in the south-west of the Territory around Rungwe Mountain as a centre.

From the standpoint of soil, water and climate, portions of the volcanic regions include some of the most favoured and attractive land in the Territory. (After E. O. T.)

Mineral Resources

From the foregoing outline of the geology of Tanganyika Territory it will be observed that many minerals are definitely wedded to certain geological formations. Diamonds, for instance, are directly related to the occurrence of kimberlite pipes, from which the eluvial diamonds are derived. Gold and tin are related to granite outcrops and to main lines of shearing or crushing. Chromite and nickeliferous minerals, found as yet in minor quantities, are connected with ultrabasic rocks. Coal is limited to the sediments of the Lower Karroo. Mica-pegmatites are known only in the areas occupied by the Basement System.

The principal mineral deposits of Tanganyika, arranged according to value of output, are *gold, diamonds, tin ore, salt, mica, silver, building materials, tungsten ore, lead ore, red ochre,* and *kaolin.* Of these, the first five have contributed by far the bulk of the exports, gold figuring predominantly until recent years. In 1940, for instance, the value of refined gold produced, as represented by

PLATE I

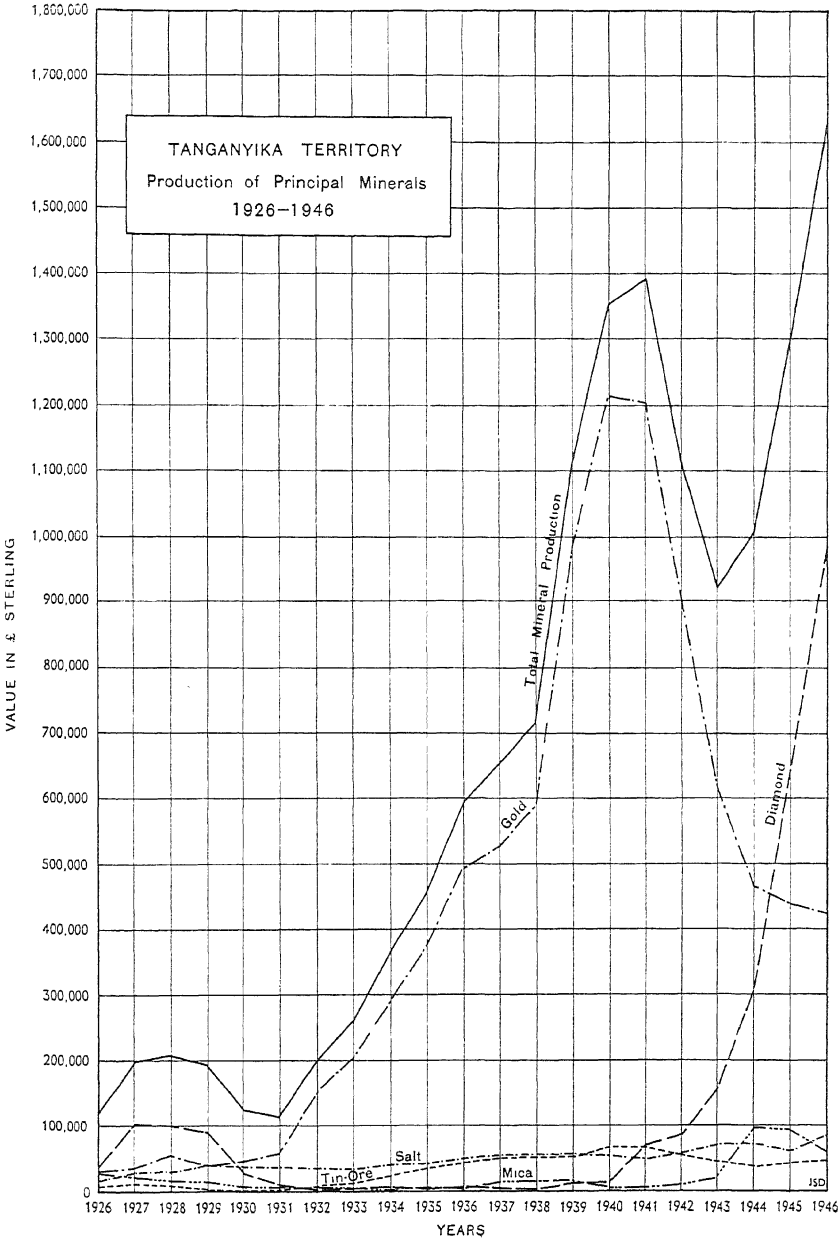

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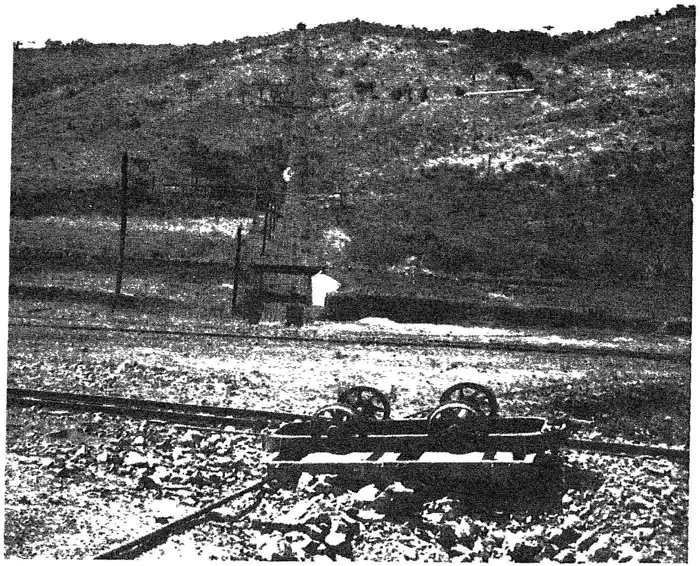
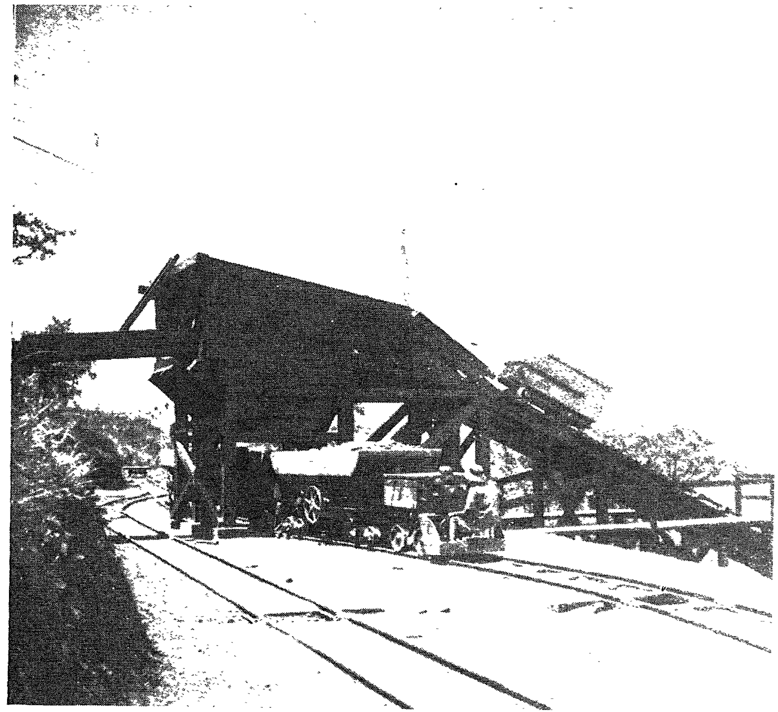
PLATE II.



[Photo: Geita Gold Mining Co., Ltd.

GOLD MINING IN TANGANYIKA.

Geita Mine, showing incline haulage for men and materials.



[Photo: Geita Gold Mining Co., L

GOLD MINING IN TANGANYIKA.

Geita Mine: inclined self-dumping skip, battery locomotive and 5-ton side-tipping trucks.

the official statistics of exports and local sales, amounted to £1,211,788, or more than eight times that of the other minerals combined, the grand total for all minerals being £1,352,614.

By 1946, however, on account of conditions arising from World War II, the production of gold had fallen markedly, but the reverse was true of diamonds, the value of which showed a noteworthy increase. Indeed, this increase was such that the total value of all minerals produced in 1946 was the highest ever recorded, the value of diamonds having reached more than double the value of gold.

The graph (*see* Plate I), illustrating the variations in annual production of the chief minerals, is most instructive. Gold production rose gradually to a peak in 1940 and has since fallen to about one-third of that figure. Diamonds in the early days constituted the principal mineral export, but production soon fell off to a very low figure and remained low until 1941, when Williamson Diamonds, Ltd., at Mwadui, began to get under way. Tin, on the whole, with a brief lull in 1929-31, has been steadily produced. Salt has gradually increased in production and the amount is now five times that of 1926.

TANGANYIKA TERRITORY—MINERAL PRODUCTION, 1926-1946

Value of Mineral Exports and Local Sales (Domestic Production) of Gold, Diamonds, Tin Ore, Salt, Mica and Building Materials

(*£ Sterling*)

	Gold. (Bullion)	Diamonds.	Tin Ore.	Salt.	Mica.	Building Materials*.	Total all Minerals.
1926 .	30,312	37,480	5,575	17,077	26,954	...	177,428
1927 .	34,630	101,480	10,555	28,644	21,000	...	196,469
1928 .	54,551	99,836	8,500	29,130	14,966	...	207,319
1929 .	38,630	88,518	2,825	39,200	14,780	9,600	193,810
1930 .	47,013	27,210	852	36,050	6,182	6,553	124,225
1931 .	58,560	9,865	1,987	36,524	2,600	4,575	114,384
1932 .	149,864	1,893	6,893	33,788	3,808	2,369	198,731
1933 .	201,886	3,861	12,213	32,262	2,629	4,577	257,608
1934 .	291,112	5,967	23,892	38,620	1,604	4,739	366,635
1935 .	371,984	2,972	32,596	39,347	5,225	1,791	452,646
1936 .	491,320	6,252	41,784	47,569	5,188	2,569	594,328
1937 .	526,338	5,070	49,488	52,667	14,081	2,834	652,442
1938 .	588,679	3,559	50,460	53,938	12,697	2,177	712,730
1939 .	982,597	12,255	50,646	54,078	15,403	1,410	1,117,254
1940 .	1,215,286	12,598	65,935	52,096	3,900	1,808	1,352,514
1941 .	1,202,111	70,236	64,787	46,910	2,950	3,243	1,391,064
1942 .	899,904	84,745	53,585	56,356	9,000	6,497	1,111,996
1943 .	612,674	155,925	44,569	71,088	21,501	13,591	922,494
1944 .	464,845	306,306	36,441	72,220	95,008	30,752	1,007,804
1945 .	439,032	638,383	41,218	61,213	90,696	23,825	1,297,619
1946 .	421,833	981,833	47,271	86,334	62,127	25,393	1,628,305

* *Include lime and in all other cases refer only to mineral mined in and within 3 miles of a township.*

As world conditions reach normality once again, the future will probably see a rise in the output of lead, copper, silver and gold. Diamond production should also increase because this country

has obtained an annual sales quota of one-tenth of the world's annual diamond sales. It is also possible that coal may be mined in the near future if the great Groundnut Scheme in the Southern Province progresses as it is hoped, and if this should eventuate, the whole economic future of the country may be considerably changed. If, eventually, the coal could be employed in smelting the titaniferous magnetite, of which there are deposits in the Lake Nyasa region, the production of iron and steel would initiate an industrial era.

Other potentially useful minerals found in the country include platinum, gypsum, apatite, nickeliferous ultrabasic rocks, magnesian limestones, kaolin and other clays, diatomite, kyanite, magnesite, optical quartz, and sodium sulphate. Many of these are already known to occur in large amount, but their development awaits the provision of easy transport facilities.

Gold

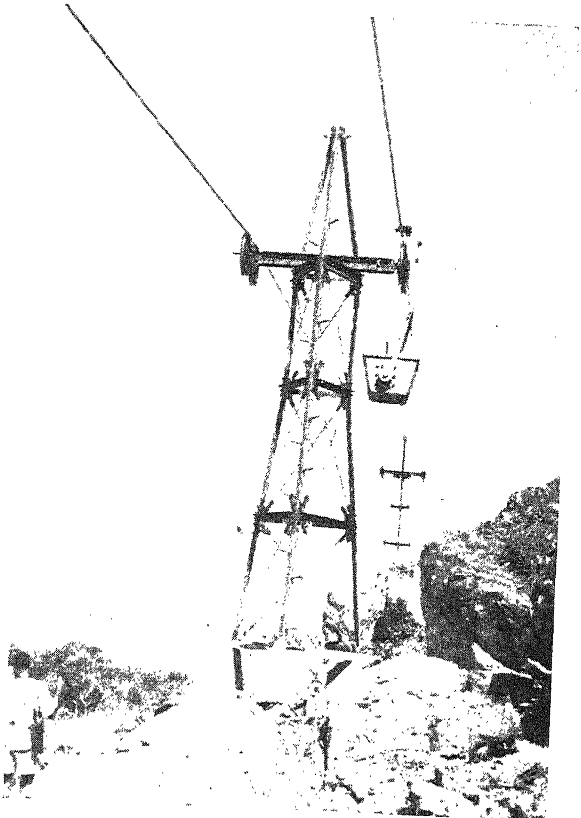
The goldfields of Tanganyika are divided into three administrative areas: I, Lake Victoria region; II, Lupa Goldfields; and III, the remainder of the Territory.

I. *Lake Victoria Region*

The principal gold mines situated in and around the Lake Province include North Mara, Buhemba, Ikungu (now defunct), Kitario, Kilimafeza and Mrangi in the Musoma District; Ngasamo in the East Mwanza District; Geita, Macmel and Busanda in the South-west Mwanza field. The gold deposits may be divided into (*a*) simple fissure-filling quartz veins, (*b*) partial metasomatic replacements with some quartz infilling of the fissures, and (*c*) sulphidic impregnations of the country rock emanating from a shear or shear zone. These veins or impregnations usually lie either close to the granite-Nyanzian contact or in strong shear belts within the area of Nyanzian rocks. Geological studies have shown that structural control is the chief factor that determines the location of a gold deposit.

The Geita Mining Co., Ltd., is now the largest single producer of gold in the Territory. After extensive exploration and development since 1934, this company completed the erection of a mill designed to handle 500 tons a day and commenced production on January 1, 1939, on a 250-tons per day basis. Enlargement of the mill to 1,000 tons per day capacity is still in progress. In addition to the Geita Mine itself, the company works four other deposits, known as Mawe Meru, Lone Cone, Ridge 8 and Prospect 30 in the same district, but the formations containing proved mineralisation are scattered over a considerable area beyond the actual holding of the Geita Company. They are similar geologically to those of the Musoma goldfield and are similarly disposed to adjacent granite intrusions. There is, however, a greater preponderance in this

PLATE III.



[Photo: Geita Gold Mining Co., Ltd.

GOLD MINING IN TANGANYIKA.

Geita Mine: Ropeway loading terminal.

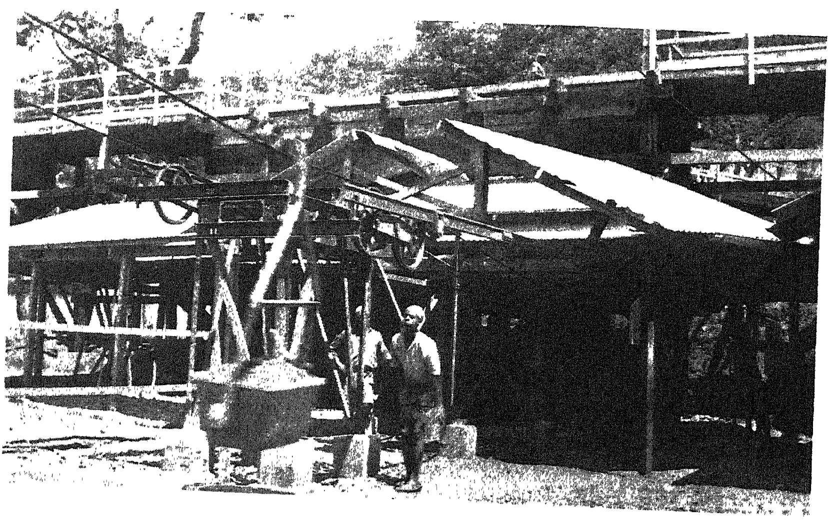


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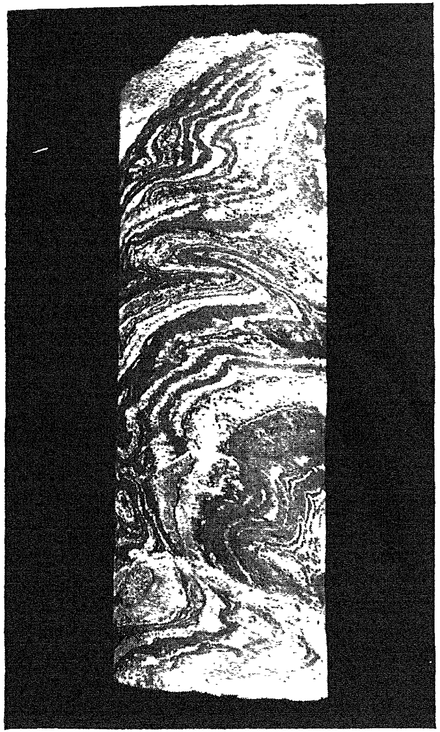
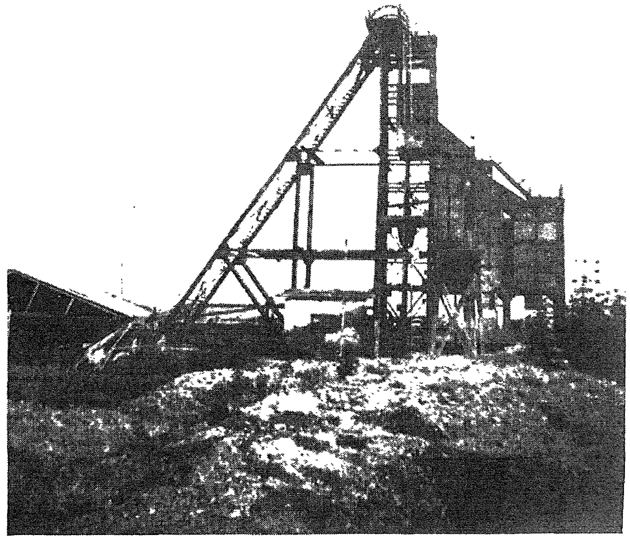
PLATE IV.



[*Photo: Geita Gold Mining Co., Ltd.*

GOLD MINING IN TANGANYIKA.

Geita Mine : Drill core showing banded ironstone.



GOLD MINING IN TANGANYIKA.

Sekenke Mine : Vertical shaft on the Dernburg Reef.

region of extensive pyritic impregnations over normal quartz reefs; Geita, Lone Cone, Prospect 30 and Ridge 8 are impregnated banded ironstone, while Mawe Meru is of the quartz reef type. In depth the mineralization of the impregnation-type of deposit is dominantly pyrite with some pyrrhotite and/or arsenopyrite in places, and there is a considerable amount of silicification but little true vein quartz. From the commencement of milling on January 1, 1939, to June 30, 1947, the following production record is worth noting:

Ore milled:		*Long tons.*
Geita		164,957
Lone Cone		57,966
Ridge 8		529,595
Mawe Meru		51,864
Miscellaneous		128
Total		804,510
Gold recovered	*fine oz.*	221,045
Silver recovered	"	39,077
Gross value bullion		£1,858,245

II. Lupa Goldfields

The Lupa Goldfields are situated on the Rukwa eastern scarp at the southern end of the Territory and north-west of Lake Nyasa. Erosion of the old peneplain surface by many streams cutting deeply into areas adjacent to gold-bearing reefs brought about the formation of a number of valuable placer deposits which were until 1936 the chief producers of gold. Since that date there has been a steady decline in the amount of placer gold won, but a corresponding increase in that obtained from quartz reefs, which are abundantly developed over an area of nearly 1,000 sq. miles.

The rocks of the Lupa region consist of a dominantly igneous complex characterised by a great diversity of rock types, such as streaky granitic gneisses, dioritic rocks, various granites and acid volcanics. Most of the reef occurrences consist typically of a system of quartz lenses *en echelon* along a shear zone. In general these individual shears lie within a major zone of shear which trends roughly east and west. Out of some 28 mines working in 1940, three are dominantly sulphidic, four are highly sulphidic and the remainder are quartz. Minerals associated with quartz and pyrite are chalcopyrite and galena, but zinc blende is known in a few cases. Tourmaline is abundant in some of the reefs.

In 1940 there were 40 lode producers and some 393 placer workers. The values of the various reefs varied from more than 10 dwt. in three cases, to an average of 4 dwt. for the rest. At the present moment the principal mine is that of Messrs. New Saza Mines, Ltd.; others working include Ntumbi Reefs, Galena, Itete, Kizumbi, Mwakimba Reefs, Venus and Safari Mines.

III. Other Regions

The principal lode gold producers in 1940 were Sekenke Mine

on the Wembere sunkland, and Kirondatal on the Iramba Plateau, both in Singida District. Placer gold was won by Uruwira (Mpanda) Minerals, Ltd., in country south of Uvinza. Sekenke Mine is now closed down, but Uruwira Minerals, Ltd., hope to increase their gold production very shortly, when the mine is fully equipped.

The gold deposits of the Iramba-Sekenke area fall into two categories : (1) quartz veins of mesothermal type, and (2) impregnation deposits. By far the larger proportion of the gold produced (1940) in the area was won from quartz veins in the greenstone-schists or diorites, and on only one producing mine (Kinyalele) is an impregnation deposit being worked. The gold in the quartz veins is of the free milling type, but may be included in pyrite or arsenopyrite. Other associated minerals are chalcopyrite, zinc blende, tourmaline, calcite and ankerite.

Placer gold has also been worked at several other localities, namely Ruvu River in the Eastern Ulugurus, Madengi and Kisigo River near Dodoma in the Central Province, in the Mbemkuru River, and also in the Mualezi River in the Bundali Hills, near Tukuyu, in Southern Highlands Province. None of these occurrences has yielded more than a few hundred ounces of gold, and most of them only a few score.

Diamonds

The only locality in which diamond mining is carried out in Tanganyika is around Shinyanga and south of Mwanza. The gems were first found in eluvial material near Kizumbi Hill in this locality, and their origin was later traced to kimberlite pipes in the vicinity. The pipes themselves, though sometimes diamond-bearing, are not rich enough in gems to be exploitable, and it would seem that some form of concentration—eluvial or alluvial—is necessary before a payable grade of material is produced by natural means.

The richest ground is the detrital material overlying or adjacent to a pipe. This detritus consists chiefly of grey grit or " cement," silcrete, laterite-gravel, waterworn or partly waterworn wash, and little-worn debris containing angular and often banded chert, flinty or jaspery silica, and ordinary quartz. Other deposits include heavy black clays, marls, sandy clays and sands. The concentrate from this wash comprises a very characteristic mineral assemblage, which constitutes an unfailing indication of its derivation from kimberlite. Yellowish and white zircon in large crystals is very abundant, besides several varieties of garnet, emerald-green (chromiferous) diopside, enstatite, ilmenite (the " carbons " of the diamond digger), besides other unusual minerals and rock-fragments. The average size and quality of the diamonds is good.

Mwadui: Williamson Diamonds, Ltd., and Alamasi, Ltd.

Early in 1940 Dr. J. T. Williamson, a Canadian mining geologist, discovered the now world-famed Mwadui occurrence, north-east of

Shinyanga, and it was not long before he realised that the gravel-rubble superficial material contained an unusually rich concentration of diamonds. Already Mwadui vies with the best South African occurrences, and the working and pitting of the superficial deposits has shown that the present production may easily be continued for many years. These pits have proved the extent of a single large irregular kimberlite pipe with its greatest length 8,000 ft. orientated 161° and greatest width 3,600 ft. The shape of the body suggests controlling fractures orientated north-south, 135°, and east-west, although the most pronounced tectonic line is 102°, as displayed by a quartz or quartzite bar extending in that direction for over two miles. There are at least two types of kimberlite.

The overflow superficial material from Williamson's is worked by Alamasi, Ltd., originally a company composed of local people, of whom Messrs. Kennedy and Macnaughton were the principals, but in 1945 the majority of shares of Alamasi, Ltd., was purchased by Tanganyika Diamond and Gold Development Co., Ltd.

These two mines have contributed almost the whole diamond production in late years, largely because diamond prospecting is now prohibited. A third producer, the late Stanley-White, worked at several localities for many years, principally at Shilole and close to Mwadui.

It is interesting to note that the yield obtained by Williamson Diamonds, Ltd., consists of about 40 per cent. gemstones, the remainder industrial diamond and bort; that of Alamasi, Ltd., is about 51 per cent. gemstones, and Stanley-White's 70 per cent. gemstones. Williamson's gemstones are said to be of very high quality, and to have a bluish to brownish tinge when seen in mass. Alamasi stones favour a pinkish hue, while an assemblage from Stanley-White's prospect near Mwadui possess a pale greenish tinge.

The largest stone so far reported weighed 174 carats and was valued for royalty purposes at £5,220, but the highest normal valuation to date is £200 a carat. A pink diamond, a "collector's piece" weighing originally 54·5 carats, was presented by Dr. J. T. Williamson to H.R.H. Princess Elizabeth on the occasion of her marriage, and was valued normally at £250 a carat. It was subsequently cut in London and yielded a magnificent pink brilliant weighing 23·6 carats. Other large stones include one of 120·15 carats valued for royalty at £7,209; the "Battershill Diamond" of 67·75 carats valued at £2,032 10s. and several others of over 60 carats each in weight.

A number of kimberlite pipes have also been discovered in the general locality of the Iramba Plateau, but these without exception have proved barren. A remarkable and perhaps unique feature is the occurrence in the Kisiriri region of this general locality of more or less flat-lying sills of kimberlite penetrating granite.

Tin and Tungsten

The occurrence of tinstone is practically limited to the north-west corner of Tanganyika adjacent to both Uganda and the mandated Belgian territories of Ruanda and Urundi, in all of which countries it is to be found. In Tanganyika it is confined to the Bukoba and Biharamulo districts, most being mined in the Karagwe chiefdom, west of Bukoba.

Briefly stated, the geology of Karagwe consists of an intrusion by granite cupolas into rocks of the Muva-Ankole System, and the later denudation and exposure of the rocks concerned.

The tin mineralization took place at the close of the intrusive episode of the granite, tin oxide (cassiterite) being deposited through the agency of volatile and chemically reactive solutions (mineralizers) in small quartz-mica veins. Muscovitic mica is a very common associate of the cassiterite ; in fact the richest portions of the veins are usually those that contain abundant mica. The chief mineral precipitated by the mineralizers was black tourmaline (schorl) ; and this readily recognisable blue-black, acicular or prismatic, and striated mineral has proved a useful field indicator of the existence of stanniferous veins, since it appears to be invariably associated with them.

Up to the present the winning of the tinstone has been largely from detritals. Quartz-mica veins, through age-long degradation of the land surface, undergo disintegration, and the cassiterite thus liberated is deposited in the immediate vicinity of the veins. Considerable concentrations of eluvial ore have resulted in this way through vertical as opposed to lateral movement of the heavy cassiterite. The last few years have witnessed increased activity in lode mining, but as the shoots of ore are patchy and commonly confined to the vein walls, constant exploration and development are essential.

The principal tin-mining areas in Karagwe are the Ibanda arena, with the numerous small mines between Murongo and Kagando ; the Kyerwa region, close to the Sina arena ; and the Kashoro arena, near Lake Mujunju. In the Biharamulo district alluvial tin has been won near Bugufi.

A discovery of the tungsten mineral, wolframite, in the small arena of Ihunjere, 13 miles south-east of Murongo, awakened interest in this common associate of cassiterite. Several tons of wolframite have so far been recovered from detritals adjacent to the wolframite-quartz veins, but the veins themselves have not proved to be worth exploiting.

Mica

The mining of mica in Tanganyika is confined exclusively to Basement System terrains. Such terrains are usually mountainous, e.g. the Usambara, Uluguru and Usagara massifs, in all of which mica is being mined. Excellent mica is mined north of Masasi in

the Southern Province, and also in the Bundali Hills in the Southern Highlands Province. Mica has also been obtained from the Ufipa and Sibwessa regions in the west. The mica is derived from coarse-textured pegmatite veins, 10 ft. and upwards in width, consisting essentially of quartz, alkali-felspar and muscovitic mica, the last being sporadically developed in discontinuous "leads." The lamellar aggregates of mica are known as "books" and vary in diameter from a few inches to upwards of 2 ft. The best quality "ruby mica" has a pinkish or purplish-red tinge and is free from inclusions and flaws. Much of the mica, however, contains inclusions of iron oxide and is badly flawed as a result of stress, and such material is of little or no value.

Pegmatites are often veritable "mineralogical museums" and these are no exception. From the dump heaps of the mica mines many interesting or rare minerals such as garnet, beryl, euclase, orthite, tourmaline, samarskite, pitchblende, etc., may be obtained. It is worth while mentioning that the only pegmatites carrying mica of economic grade are those penetrating rocks that have been subjected to high-grade metamorphism. Mica-pegmatites appear to be absent from the metacalcareous rocks of the Basement System.

Lead and Copper

Metalliferous mineralization in the Mpanda area on the boundary of Tabora and Kigoma districts was discovered in 1935 by M. de la Vallée Poussin, at present Manager of Uruwira Minerals, Ltd., a geologist who started his systematic prospecting from the Northern Rhodesia boundary northwards until he discovered the Mpanda area and settled there. The alluvial gold appeared richest in this area and there were signs of reef mineralization developed along strong north-south shears. The first of the two propositions explored was the "D" reef copper-gold occurrence, believed in the first place to be a gold reef, but found in depth to contain quantities of copper, which may be more important than the gold content. The Mukwamba occurrence was at first believed to be one of auriferous and argentiferous galena with subsidiary quantities of copper, but recent exploration has disclosed equally large and massive chalcopyrite-siderite filling. Owing to the war full production has been much delayed.

Mpanda mineral field is likely to prove one of Tanganyika's greatest sources of wealth, indeed, it is thought that Mukwamba Mine may become one of the largest base metal mines in Africa. Lead, copper, gold and silver will be produced as soon as the mine is ready for production. The technical management has been taken over by Union Corporation, Limited, of London and Johannesburg. It is estimated that there are (proved and partly proved ore) 2,000,000 tons of lead ore with an average lead content of 16 per cent. or over. Geophysical prospecting followed up by diamond

drilling and exploration is designed to locate other ore-bodies along the east-west Myakalisa shear.

In addition, within the 42 sq. miles of the lease area held by the Company there are numerous gold-bearing quartz reefs, and wolframite also has been recorded from the southern portion of the area.

A railway is in course of construction from the Central Railway near Kaliua, west of Tabora, to Mpanda; its completion will hasten the development of and production from this promising mineral area.

Salt

Salt held second place in the mineral production of the Territory in 1939, but by 1941 had dropped to fourth place. That salt is an important article of local trade is demonstrated by the fact that the increase in production between 1926 and 1941 has been steady and that the value of the salt produced within this period has amounted to well over half a million pounds sterling. This figure does not take into account the very considerable quantity that is collected directly by tribal natives from the various salt lakes of the interior where there are large deposits. Of the recorded production the largest portion is obtained from brine springs at Uvinza; most of the remainder comes from the coastal region, while there is a small output from salt-pans in the Lake Rukwa depression.

(*a*) *Uvinza*

The largest individual producer of salt is the Nyanza Salt Mines (Tanganyika), Ltd. The salt is obtained from a brine spring at Uvinza on the Central Railway in the Kigoma District about 70 miles from Kigoma, and a large proportion of the output is exported *via* Lake Tanganyika to the Belgian Congo and some to Northern Rhodesia. There are about 10 springs in this locality, of variable productivity and salinity; only one, the Nyanza spring, is at present being exploited, but the company, of which the Tanganyika Government is a shareholder, has rights over the whole series. An analysis, quoted by Tornau, of a sample of brine taken in March 1911 from the Nyanza spring, shows that the brine contained 194·659 gm. of saline material per litre, of which about 90 per cent. was NaCl. The concentrations of salt in the other springs are said by Tornau to range from about 3 per cent. up to about 11 per cent. The seasonal variation in the Nyanza spring is from about 15 per cent. to about 19 per cent., the brine being, as might be expected, strongest in the dry season. The yield of the Nyanza spring was said by Tornau to exceed 50 cu. metres per day from which the production of salt was 140 cwt. in the dry season and 120 to 125 cwt. in the wet season.

(*b*) *Lake Rukwa*

In the Mbeya District, the Lake Rukwa (Ivuna) salt-pans furnish salt obtained by solar evaporation of brine. A sample of this concentrated brine, analysed at Dodoma, was found to contain 356 gm. of total solids per litre. Previous to 1930 wood fuel was used to evaporate the brine in special furnaces. Production is of the order of a few hundred tons yearly.

(*c*) *Coastal Salt Works*

The principal production of salt in the coastal belt is in the Eastern Province, though there is some unrecorded native production in the Southern Province. Owing to the excessive humidity and not inconsiderable rainfall (46 in. at Dar es Salaam in 1930), the solar evaporation of sea-water has its limitations as a means of obtaining salt.

In the past there have been numerous independent producers of salt in the coastal areas, but in 1933 Tanganyika Salt, Ltd., of Dar es Salaam, amalgamated the five leading producers, and the greater part of the coastal salt is now disposed of through this marketing organization.

(*d*) *Lakes of the Northern Rift Zone*

Much salt is collected by natives from various lakes in the interior. It has been estimated that the quantity removed annually by natives from the south-east portion of Lake Singida is unlikely to exceed 500 tons, that the rate of regeneration is considerable, and that the balance of salt, after native requirements had been satisfied, would be sufficient to permit the establishment there of a small European-directed salt industry. Approximate quantities for the whole of the lake are given as 2,471,000 tons NaCl and 2,118,000 tons Na_2CO_3.

Selected analyses of salts from the most important saline lakes of the northern portion of the Territory are given below.

Selected Analyses of Salts obtained from Saline Lakes in Tanganyika Territory

(*Per cent.*)

Constituent	1 Lake Singida.	2 Lake Eyasi N.W. end (Soda rich).	3 Lake Eyasi S.E. end (Salt rich).	4 Lake Eyasi (as taken away by natives).	5 Lake Balangida Lelu (Balang-dalulu).	6 Lake Balangida (Balangda).	7 Lake Natron.
NaCl	91·72	13·1	75·5	83·0	72·52	40·8	20–30
Na_2CO_3	—	43·8	8·6	8·1	1·19	21·7	53–65
$NaHCO_3$	—	25·7	6·4	4·2	14·89	6·4	—
Na_2SO_4	0·68	7·8	2·3	0·8	9·82	23·8	2
K_2SO_4	—	—	—	—	2·81	—	—
KCl	—	—	—	—	—	2·7	—
$MgCl_2$	0·86	—	—	—	—	—	—
Na_3PO_4	—	—	—	—	—	0·3	—
Insoluble	0·66	4·4	0·6	—	—	0·5	—
Moisture	3·90	12·1	3·4	3·1	—	4·2	—

Probably the largest deposit of salt crust is that on Lake Natron on the Kenya border, which, according to computations by Uhlig and Muller in Scholz, covers an area of 570 sq. km. and contains about 72,000,000 tons of salt. The chief disadvantage of this deposit is the composition of the salt which consists of about one-quarter sodium chloride and two-thirds sodium carbonate. (After F. O.[1])

Kaolin

Large kaolin deposits are known in a number of localities, the most important of which occur on the peneplaned high central plateau region of Tanganyika. Close to Malangali School on the Iringa-Mbeya (Great North) main road there is a large area of weathered and kaolinised granite, which has given rise to large deposits of relatively pure white kaolin, and in Uwanji in Northern Njombe District, masses of decomposed leuco-gabbro yield deposits of high-grade kaolin. These occurrences are, however, situated at some distance from rail communication and also from sources of fuel.

Close to Dar es Salaam at km. 26 to 28 in the Pugu Hills there is an occurrence of soft kaolin-sandstone, the potentialities of which are being explored. The kaolin occurs as a matrix to the sandstone and bands of pure kaolin form the more argillaceous facies of the rock. The kaolin-sandstone occupies most of the Pugu Hills east of Dar es Salaam and thus the deposit may be considered to have considerable possibilities. The kaolin is extracted by washing the crushed rock and allowing the resulting creamy liquid to settle. The final washed kaolin is said to be 30 per cent. of the original material, but the washed kaolin is 99·8 per cent. pure. The amount of the impurities is, however, considered to be too small to preclude the use of kaolin for most purposes. Already several hundred tons of this kaolin have been exported.

Coal and Iron

Of the eight coalfields so far known in Tanganyika, five are relatively small, but the other three promise to be extensive. All the coal lies in and near the great Nyasa-Rukwa Rift Valley. Commencing from the north-west they are: (1) Namwele-Mkomolo, on the Ufipa Plateau; (2) Muze, in north-west Rukwa; (3) Galula, in south-west Rukwa; (4) Kiwira-Songwe, at the north-west end of Lake Nyasa; (5) Ruhuhu basin, east of Lake Nyasa; (6) Mbamba Bay, south-east of Lake Nyasa; (7) and (8) Muhukulu and Njuga Coalfields in the north-west Ruvuma Basin. Geographically the last five are related to the coalfields of Nyasaland and Northern Rhodesia (Luangwa Valley), which in turn link up with those of Southern Rhodesia and South Africa.

[1] Frank Oates, late Chief Geologist, Geological Survey of Tanganyika Territory.

The term "coal reserves," as used in this article, refers to the coal which may be inferred on general geological grounds to be continuous and indicates the order of magnitude of these reserves which can be reasonably expected.

A conservative estimate of the coal reserves in Tanganyika is summarised as follows:

Coalfield.	*Reserves (tons).*	
Namwele-Mkomolo .	7,500,000	Based on thickness of 45 in. over about 2 sq. miles.
Muze	10,000,000	Based on thickness of 10 ft. over about 1 sq. mile.
Galula	2,000,000	Based on thickness of 3 ft. over about 1 sq. mile.
Kiwira-Songwe .	140,000,000	Based on thickness of 14 ft. over about 12 sq. miles.
Ruhuhu . .	800,000,000	Based on thickness of 20 ft. over about 54 sq. miles.
Njuga . . .	23,000,000	Based on thickness of 3 ft. over about 10 sq. miles.
Muhukulu . .	150,000,000	Based on thickness of 10 ft. over about 20 sq. miles.
Total . .	1,132,000,000 tons	

Without a proper topographical and detailed geological survey supported by suitable borings and pittings to gauge the exact thicknesses and the extent of the persistence of the various seams no exact figure can be calculated. It is probable that some of the figures considerably underrate the total coal reserves of the Territory; for instance, it is submitted that the actual figure for the Kiwira-Songwe field is almost three times the above estimate. Similarly the figure for the Ruhuhu Coalfields can only be considered a token estimate, having been calculated on the basis of a total of 54 sq. miles, whereas the Karroo rocks occupy some 1,330 sq. miles. The two coalfields north and south of Manda have been omitted, together with the unknown potentialities of the Ndembe and Lumecha coalfields.

There is also every possibility of the Coal Measures extending eastward and south-eastward from the Muhukulu River, and it is likely that the total coal-bearing area in the upper Ruvuma region includes an area of 600 to 700 sq. miles, in which case the total coal-bearing area in Southern Tanganyika would aggregate to 2,000 sq. miles. It is possible to revise these conservative estimates and to submit that the figures given below suggest the potentialities of this region.

Coalfield.	*Potential Reserves (tons).*	
Kiwira-Songwe .	500,000,000	Based on thickness of 14 ft. over about 40 sq. miles.
Ruhuhu . .	4,000,000,000	Based on thickness of 5 ft. over about 1,000 sq. miles.
Muhukulu . .	2,000,000,000	Based on thickness of 5 ft. over about 500 sq. miles.
Total .	6,500,000,000	tons of coal in Tanganyika Territory in the Lake Nyasa region.

The greatest drawback from the industrial viewpoint is the general lack of coking coal. In only the Kiwira-Songwe field have coking coals so far been proved; they have, however, been proved to occur extensively in the Mount Waller and Sumbu coalfields of Nyasaland. It seems reasonable to expect to find by further prospecting seams of coking coal in the Ruhuhu basin.

The general conclusions that may be drawn from the study of the facts so far observed may be briefly summarised as follows:

(i) The thickset coal seams of East and East Central Africa are situated in the Lake Nyasa region; they are probably the more persistent and are generally the better coals.

(ii) Coal seams appear to die out from the region of Lake Nyasa in a north-eastward direction; no coal seams of more than a few inches have yet been located in the Rufiji and Ruaha basins. North-westwards from Lake Nyasa, coal seams are confined to the Rukwa basin, but continue westward into Belgian Congo.

(iii) Coal is unknown north of the Tanganyika Central Railway.

(iv) Exploration for coal should be continued in the Ruvuma basin in both Portuguese East Africa and Tanganyika and also in the Luangwa basin in Northern Rhodesia.

In addition to coal there are, situated 35 miles to the north of the Ruhuhu coalfields, large deposits of iron ore (titaniferous magnetite); some 1,200,000,000 tons is a conservative estimate of the amount at Liganga in Southern Upangwa. In addition, the Germans recorded deposits of more iron ore in the Matengo Highlands and along the Portuguese Boundary, neither of which are far from the Ngaka and Muhukulu coalfields respectively. It is thus obvious that all the elements for the development of an industrial region exist. The large deposits of coal could also be used in several ways, in addition to the smelting of iron ore. The possibilities of converting the coal into fuel oils were discussed by Oates (1931), and chemical research into the hydrogenation and distillation treatments of coal has advanced considerably in the last 16 years, enough to place this proposal into the region of practical development. The coalfields are conveniently placed for distribution in Central and East Africa and await the completion of the Southern Railway project to initiate the preparatory work of making the necessary surveys.

In addition to the proposed Southern Railway there is the recent railway project in the Southern Province in connection with the "Groundnut Scheme." Under this scheme some 55 units, each of 30,000 acres, are to be cultivated and it is anticipated that some 300,000 tons of groundnuts will be produced annually. In order to transport these large quantities to the coast it is proposed to build a railway from near Mikindani on the coast up to the Lukuledi valley and thus connect the various areas under cultivation.

The most westerly terminus of this railway route is about 150 miles from the Muhukulu coalfield. There is thus a very great possibility that within a few years, if the Muhukulu coalfield fulfils all expectations, that coal could be mined and exported from Southern Tanganyika. The completion of such a project would thus hasten the day when the possibilities of opening up the Ruhuhu coalfields and Liganga iron deposits may be seriously considered.

Finally the following proposals are made with a view to facilitating the opening up of the southern part of Tanganyika Territory :

(i) Detailed geological survey and prospecting of the whole region, in particular the coalfields, supported by drilling and a pitting campaign.

(ii) All-weather road development between the coastal region at Lindi and the hinterland to Songea and to Njombe.

(iii) Topographic survey of the country west and south of the Njombe-Songea-Tunduru-Masasi road.

(iv) Metallurgical research carried out on the titaniferous magnetite ores of Liganga and elsewhere in order to devise a simple and effective method of smelting the ores. This research should include the possible new uses of titanium-iron alloys and steels.

(v) Fuel research into the economic use of the coal, especially into devising a simpler and cheaper method of converting it into fuel oils.

Gypsum

The only promising deposit of gypsum is located at Mkomazi at Km. 167 on the Tanga Railway. The gypsum deposit is a bed formed among other lake beds, and the richest sheet lies 500 ft. to the east of the station, but the lake has been very much more extensive. Gypsiferous beds are also found for some distance up the southern slope of Lasa Mountain. A conservative estimate of the amount of gypsum available is 105,000 tons. The beds vary from 1-3 ft. thick and the overburden averages about 1-3 ft. A chemical analysis of the gypsum collected from the area close to the station yielded 78 per cent. $CaSO_4.2H_2O$, most of the impurities being silica, insoluble material and lime. Detailed exploration and pitting will undoubtedly prove that the above conservative estimate is a mere fraction of the quantity that exists at Mkomazi.

Apatite

No rock phosphate (phosphorite) has as yet been found in Tanganyika Territory; the nearest examples are some locally phosphatized limestone underlying bat guano deposits in certain limestone caves. These deposits are found in caves hollowed out of crystalline limestones of the Basement System and from Jurassic oolitic limestones.

A deposit of phosphatized limestone is known on Latham Island, south of Zanzibar, and about 44 miles east-south-east of

Dar es Salaam. The rock is oolitic in form, grains of unaltered coral being cemented with calcium phosphate, and it is covered with a varying thickness of guano, estimated at 3,500 tons. There appears to be some 190,000 tons of low-grade rock phosphate, averaging 8 per cent. P_2O_5 or 17·5 per cent. tricalcium phosphate.

Mineral phosphate rock or apatite-bearing rock has been recorded from three localities, but so far only one, an apatite-bearing crystalline limestone at Zizi, south of Kisaki, south of the Uluguru Mountains in Morogoro District, shows any promise of exploitation. The apatite-limestone is a narrow, long lenticular raft lying within the gneisses of the Basement System. It is estimated that 2,000,000 tons of the apatite-limestone may be quarried from every 100 ft. depth of the rock. Chemical analyses show that the rock varies from 3 to 10 per cent. P_2O_5 or an average of 7·22 per cent. tricalcium phosphate.

Mineral dressing tests have shown that by first calcining the rock, then slaking, sieving and washing, the product can be increased to over 55 per cent. tricalcium phosphate, which would place it among second-grade phosphate rock. Lack of communications in the vicinity hinder the development of this deposit.

Platinum

In the sub-districts of Ukinga and Upangwa of Njombe District, situated partly within the Livingstone Mountains range and partly east of them, there are outcrops over considerable areas of coarse leucogabbro and allied basic intrusives. A study of these gabbroic bodies has shown that the process of magmatic differentiation appears to be responsible for the deposition of large masses of titaniferous magnetite. The gabbroic bodies pass from south to north into two fractions, a more basic including olivine-gabbros and norites, grading ultimately into ultrabasic rocks with small bodies of chromite, and an acid fraction with its extreme differentiate, a syenogranite. The geological setting is therefore favourable for the location of the platinum metals. Platinum was first detected in minute quantities in stream-concentrates collected from the serpentine-norite country. Further, a number of rock samples collected from the various gabbros, norites and syenogranites was submitted for spectrographic analysis. Out of nine samples sent, seven revealed the presence of platinum, three of which contained an estimated platinum content of 0·0001 per cent. or about 16 grains per ton. This content approaches that of commercially workable ores.

As these samples were collected from widely distributed regions covering some 600 sq. miles of country and from all rock types of this plutonic complex, it is apparent that there is a distinct possibility of locating economic deposits of platinum within the region of the leucogabbros, anorthosites, norites and acid differentiates of the Gabbro-Volcanic association.

Graphite

Graphite, chiefly in the flake form, is distributed rather widely in certain of the areas of the Basement System, usually as a graphite-gneiss or graphite-schist, invariably associated with crystalline limestone. The best known occurrences are in the vicinity of the Uluguru Mountains, in the Mpwapwa District, in the Handeni District, in the hinterland of Lindi, and in the Mahenge District.

The graphite deposits from Mtombozi, near Morogoro, have recently been sampled by the Geological Survey and ore-dressing tests carried out on the samples at Dodoma. It was found that by two-stage froth-flotation followed by a light flattening grind and reflotation, yields of crucible-grade flake graphite per short ton of material treated were as follows:

Deposit.	*Yield in lb.*	*Per cent. carbon.*
Tulo . .	67	86·3
Kisauke . .	124	94·6
Mungwi . .	171	91·2

A conservative estimate of tonnage available in the Mtombozi deposits based on a length of one mile, a continuous width of 30 ft., and a depth of 100 ft. is 1,000,000 tons, a ton being reckoned on a figure of 15 cu. ft. of graphite-schist. With an average recoverable-graphite content of 5 per cent., the quantity of graphite available here would be about 50,000 tons.

Diatomite

A number of impure, earthy, diatomaceous deposits have been recorded from widely separated localities in Tanganyika within the Rift Valley zone. Although such material contains a variable proportion of the siliceous tests of diatoms, it is usually too impure to possess any value as diatomite. Three deposits of what is believed to be good grade diatomite occur in the lower parts of the Kagera River valley in localities accessible to the Lake Victoria transport systems. The first deposit outcrops over a length of about 1,400 yds., in an east-west direction, near milestone 8 from Nyakanyasi on the Nyakanyasi-Kikagati road. The second lies on the north bank of the Kagera River, between Nyakanyasi and Kyaka, and the third on the south bank of the Kagera River about 5 miles west of Kyaka. Chemical analyses of two samples show that the silica content is 75 and 77 per cent. respectively; the R_2O_3 content is 12 and 13 per cent. for the same samples.

The diatomite lies in beds varying between 9 in. and 3 ft. in thickness overlain by 9 to 13 ft. overburden. It is believed that the deposit is extensive over a considerable area and that a large tonnage is available.

Nickel in Ultrabasics

Nickel-bearing minerals have been recorded from several localities, the most important of which is a weathered nickeliferous serpentine outcropping on Kabulwanyele Hill in Ubende, South Kigoma District, containing a nickel-bearing chlorite, nepouite. The nickel

content is low, rarely attaining more than 1 per cent., with an average of 0·63 per cent., but there is a large ore-body. It is estimated that some $2\frac{3}{4}$ million tons of nickeliferous serpentine are available within the first 20 ft. These figures are based on the pitting of an area approximately 2,400 ft. by 1,450 ft., or 80 acres. There is, however, a real difficulty in extracting the nickel from the chlorite, experimental chemical work on this problem having so far been unsuccessful.

Other Minerals

A *manganiferous iron ore* is known from northern Ufipa District, which may prove to be workable if the Muze Coalfield should be developed. *Glass sands* are known from Ufipa and Bukoba districts on the shores respectively of Lakes Tanganyika and Victoria. Other minerals, which have been found in small quantities, but which remain to be found in economic amounts are *magnesite, chromite, corundum, kyanite, bauxite, manganese oxides,* rare earths and minerals containing *uranium.*

A glance at the mineral map of the Territory will show that a great variety of potentially useful minerals is known to occur and there seems every reason for expecting that further deposits of both known and other minerals remain to be revealed. It is unlikely that the present goldfields, which have been prospected for so short a time, are nearing exhaustion. By analogy, the story of recent diamond discoveries is a demonstration of this improbability.

With this in mind the Tanganyika Government has made application under the Colonial Development and Welfare Act for a free grant to cover the expenses of a geological reconnaissance survey to explore the mineral possibilities of the still unexplored regions of the Territory. It is planned to traverse the country by reconnaissance during the next decade with the additional staff of 10 geologists. The areas to be covered are given priority on the basis of (1) areas which from our present geological knowledge are considered likely to contain economic minerals, (2) areas in proximity to main communications, and (3) general agricultural (Groundnut Scheme) considerations. At the same time a team of five geologists on the Territory's established staff will be engaged on detailed geological survey of the known coalfields, and also on extending known mineral fields such as the gold and tin fields.

Nevertheless, because of the long distances involved, all mineral development will always be dependent to a large extent on increased and cheaper transport facilities.

In conclusion the writer would like to pay tribute to the very valuable work carried out from time to time by both the British Museum (Natural History) and the Imperial Institute, Mineral Resources Department, whose professional and technical staffs have continually helped in identifying peculiar and rare minerals, in carrying out long and difficult chemical analyses and in providing information.

ABSTRACTS AND NOTES

The Revised Geological Map of Southern Rhodesia.—A new edition of the Provisional Geological Map of Southern Rhodesia on the scale of 1 : 1,000,000, dated 1946, together with an explanatory 70-page booklet by Mr. A. M. Macgregor, Director of the Geological Survey, has recently been issued. The accompanying booklet, which is entitled "An Outline of the Geological History of Southern Rhodesia" (*Geol. Surv. Bull. No.* 38, 1947) gives an excellent summary of present knowledge of the geology and mineral deposits of this important region. Compared with the previous edition of 1936, the new map shows considerable improvements, especially in the increased number of formations now distinguished, and the greater detail portrayed.

The formations of the gold belts, previously grouped as Basement Schists, are now divided into three stratigraphical systems, the Sebakwian, Bulawayan, and Shamvaian. The oldest system, named from the Sebakwe River in the Que Que district, is characterised by magnesium-rich metamorphic rocks, talc-schists and granulitic rocks frequently associated with serpentines. It contains the valuable chromite deposits of the Selukwe district and the Shabani asbestos deposits. The Bulawayan System is characterised by a great thickness of greenstone lavas, with interbedded banded ironstones and other sedimentary rocks. It is the most widespread formation of the gold belts, in the Midlands approaching 40,000 ft. in thickness, and contains iron ore deposits as well as some of the few workable limestones in the Colony. Resting unconformably on the earlier formations are the coarse sediments now grouped in the Shamvaian System, named from Shamva in the Mazoe Valley but of widespread occurrence, which are frequently altered by metamorphism so as to simulate igneous rocks.

The granite and granitic gneiss complexes which occupy vast areas have yet to be sub-divided into their many variants, and still appear as a uniform pink on the map, but both north and south of the main granite areas wide belts formerly shown as granite and gneiss are now shown as paragneiss, in part believed to belong to the late pre-Cambrian Lomagundi System. The gneisses of the Wankie tinfield are tentatively referred to the latter group, which suggests that the tin-tungsten mineralisation may be of similar age to that of the Belgian Congo and East Africa. Rocks of the Umkondo System, the youngest pre-Karroo formation in Rhodesia, and formerly known only in the south east, are now shown in the Lomagundi district and along the Zambesi, thus affording closer links in the chain of outcrops between its suggested equivalents, the Waterberg to the south and the Kundelungu to the north.

A useful innovation, intended primarily to delimit more closely the possible coal bearing areas, is the subdivision of the Karroo sedimentary formations into Permian (Ecca and Lower Beaufort

equivalents) and Triassic (part of Stormberg). This use of European nomenclature is quite a departure from tradition in African geology. The Karroo lavas, referred doubtfully to the Jurassic, are also subdivided into basalts and rhyolites, and the remarkable alkaline ring complexes containing apatite and vermiculite deposits recently discovered in the Sabi Valley, and referred to the same period, are also shown. A new phase of mineralisation of late- or post-Karroo age is indicated, to which workable scheelite and fluorspar deposits and occurrences of copper and mercury may be referred.

Post-Karroo sediments in the Zambesi Valley and between the Sabi and Limpopo rivers are now shown as Cretaceous, as they resemble the deposits of Northern Rhodesia and Nyasaland that have yielded bones of dinosaurs. The Kalahari Sands, formerly classed as Cretaceous, are now believed to be mainly Pleistocene.

The map has been extended beyond the political boundaries of Southern Rhodesia to include the 2,000 sq. miles of the Tati Concession. Although situated in the Bechuanaland Protectorate, this Concession is administered as part of the Bulawayo mining district.

T. D.

The Pegmatites of Central Nigeria.—The great bulk of the Nigerian cassiterite and columbite is obtained from the alluvial deposits associated with the Younger Granite intrusions in north-central Nigeria, but it is perhaps less generally known that, in addition, several hundred tons of tin concentrates are won annually from the independent pegmatite tinfields in central Nigeria. Although this represents less than four per cent. of the total annual Nigerian production, the pegmatites from which it is derived are, nevertheless, of considerable interest on account of the occurrence in them of high-grade tantalite and other potentially valuable minerals such as mica, beryl, and monazite. They have recently been specially studied by R. Jacobson and J. S. Webb, of the Nigerian Geological Survey, whose results are published in *Bulletin No.* 17 of that Survey, entitled "The Pegmatites of Central Nigeria." The investigation arose as a result of the need to increase tantalite production during the years 1943-45, the presence of high-grade tantalite ores having already been recorded from the pegmatites of central Nigeria.

Pegmatites are widely distributed throughout the pre-Cambrian complex in Nigeria, but the investigations were limited to a broad belt of country, 120 miles long, extending from Jemaa in Plateau Province to the Egbe district in Kabba Province, which includes the most important deposits. Attention was directed mainly to the Wamba-Jemaa region in the south-western part of Plateau Province, the chief centre of pegmatite tin production, and to the north-western part of Kabba Province where high-grade tantalite occurs. A number of isolated occurrences in Benue, Niger and Ilorin Provinces were also visited. In all, several hundred pegmatites,

including many mineralised dykes, were examined, particular attention being given to the detailed mineralogy and paragenesis.

The Younger or Plateau Granites comprising a well-defined suite of intrusive biotite- and riebeckite- granites in north-central Nigeria, which gave rise to the most important Nigerian deposits of cassiterite and columbite, are known to be pre-Upper Cretaceous, and although they have been provisionally accepted as pre-Cambrian they may well be considerably younger. The term " Older Granite " on the other hand embraces a variety of pre-Cambrian granites which probably belong to several different periods of plutonic activity. They range from more or less non-foliated granites to strongly gneissose varieties that merge imperceptibly into the gneisses. One of the most widespread types is a coarse, gneissose, porphyritic biotite-granite.

All the Older Granites are traversed by numerous dykes of pegmatite, many of which are albitised to an appreciable extent. Although the pegmatites also penetrate the schists and gneisses at considerable distances from the Older Granite outcrops, there is a marked concentration around the granites, and the general field associations clearly indicate that the pegmatites, including the tin-bearing varieties, are genetically related to these granites. In the course of the investigation it has been shown, not only that the great bulk of the tin and columbium-tantalum ores of the region examined were formed during the late-stage albitisation of the pegmatites, but that there is a genetic relationship between these pegmatites and a phase of the Older Granites. There were thus two distinct periods of tin-mineralisation in Nigeria.

The Kabba area is of special interest because there the ratio of columbite-tantalite to cassiterite is much higher than usual, although tin is still predominant. At several localities in Kabba Province, principally in the district to the south-east of Oke Oloke, quartz-andalusite-sillimanite veins contain, in addition to white mica, garnet, cassiterite, and a little chrysoberyl, a considerable amount of nigerite, a new tin-zinc mineral occurring in the form of small hexagonal plates and often associated with green spinel. Nigerite has been more fully described elsewhere (*Mineralog. Mag.*, 1947, **28**, No. 198, 129-136). Although this mineral is stated to be present in considerable amounts in two of the occurrences, it is likely to remain more of scientific than of economic interest.

In addition to quartz, felspars, and micas, including lepidolite, the following minerals are found in these pegmatites: tourmaline, magnetite, garnet, beryl, cassiterite, columbite-tantalite, microlite, tapiolite, ilmenorutile, apatite, monazite, amblygonite, lithiophyllite-triphyllite, zircon, bismuthinite, green spinel. Scheelite and gold have been found in the concentrates, but not *in situ*.

Individual mines in the pegmatite tinfields are generally comparatively small affairs, and most of the ore is won from small scattered eluvial deposits. Numerous dykes have been worked

opencast to a depth of about 50 ft., but no underground mining has ever been attempted. The deposits are usually worked by tribute labour, which naturally results in the rich pockets being worked out and the low-grade ore being neglected. The combination of lack of adequate water for sluicing, transport difficulties, and the patchy nature of the pegmatite mineralisation accounts for the relative unimportance of the pegmatite tinfields.

It is a fortunate fact that the cassiterite from the pegmatites is usually non-magnetic, enabling the columbite-tantalite to be extracted by magnetic separators. It is also fortunate that all members of the columbite-tantalite suite, ranging from about 5·3 to over 7·8 in specific gravity, are present. Mixed columbite-tantalite ore can thus be split into columbite and tantalite fractions on concentrating tables. Some 15 tons of high-grade tantalite were won from the Kabba area in 1943-44, but generally speaking most of the tantalite deposits have proved to be uneconomic.

Attempts, so far all uneconomic, have been made to work mica in a number of the pegmatites. Although beryl is one of the most common minor constituents of the pegmatites, it is not generally present in quantity, but a large segregation of beryl has recently been discovered in a dyke south of Okere and an experimental shipment of 20 tons has been made. Monazite is generally present in the cassiterite-tantalite concentrates, and it is probably derived largely from the pegmatites. At the present price level, however, it is not even profitable to separate as a by-product.

Among the principal geological results is the conclusion that the degree of albitisation is the only reliable guide to the intensity of mineralisation, and it may be said that the economic deposits are almost exclusively associated with intensely albitised microcline-quartz-muscovite pegmatites. Fortunately, the fine-grained sugary albite and the platy cleavelandite are easily recognised in the field, and are readily distinguished from the potash-felspar. It is also true that the bulk of the economic deposits are associated with comparatively small dykes, and that most of the larger pegmatites are barren. The biotite-bearing varieties are seldom of any economic importance.

Thus the pegmatites of central Nigeria, from the point of view of the mining man, share much of the fickleness of pegmatites the world over.

A..W. G.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

THE MINERAL KEY. By Howard B. Graves, Jr. Pp. viii + 178, $7 \times 4\frac{1}{2}$. (New York and London: McGraw-Hill Book Company, Inc., 1947.) Price $4.00.

This admirable little pocket book is expressly designed for amateur mineralogists and mineral collectors, and consists essentially of a set of determinative tables for the identification of more than 800 minerals without the use of expensive equipment or special training in mineralogy. Initial classification into 31 tabulated groups is based upon colour, streak, cleavage, lustre, and the presence or absence of combined water. Within each group, minerals are arranged in order of their hardness, and this, with the determination, when necessary, of fusibility, the observation of other simple physical properties and the use of simple chemical tests, should be sufficient to identify the large majority of minerals. In addition to these 31 groups there are auxiliary tables for fibrous minerals, earthy minerals and the mica family. It is suggested that confirmation of identification should be made by reference to a standard textbook on mineralogy.

The tests described involve only the use of easily obtained, inexpensive chemicals and simple apparatus, the construction of which is explained. The determination of the physical properties on which this Key is based, and the simple chemical tests used are fully described. Specific gravity plays no part in this classification, for the author believes that seldom does the amateur possess the necessary apparatus. All the chemicals and equipment described can be stored in a suitable box which may also be designed as a portable field kit.

The book is well arranged and singularly free from misprints. It should prove invaluable to the enthusiastic amateur, and should also be of considerable use to the prospector, the mining engineer and the like, working where laboratory facilities are not available.

A. H. S.

IGNEOUS MINERALS AND ROCKS. By Ernest E. Wahlstrom. Pp. ix + 367, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Limited, 1947.) Price $5.50 (33*s*.).

This is an elementary but comprehensive textbook for students of igneous petrography. The first half deals with the optical mineralogy used for the identification of the minerals of the igneous rocks. After outlining the technique of microscopic identification in both thin sections and immersion media, and indicating supplementary physical and chemical methods of examination, the author

devotes 92 pages to the systematic description of the minerals. Tables are further supplied for mineral identification purposes.

The second half of the book, dealing with the rocks, discusses their field relations and characters very briefly, their chemical and mineralogical composition and classification, and devotes 71 pages to their systematic description. A semi-quantitative classification of igneous rocks is adopted, in general following Rosenbusch in a qualitative sense and Iddings and Niggli in a quantitative sense. For purposes of quantitative classification the author regards albite as alkali felspar rather than as plagioclase, thus differing from Johannsen and Shand. He wisely advocates the use of the well-known rock names with mineral, chemical or colour modifiers, and merely lists with a brief definition the innumerable special names based on rare or unusual features. The book is illustrated by more than a hundred drawings, photographs and microphotographs, but some of the latter are rather poor.

On the whole the book can be recommended as a handy text-book for use in the petrographic laboratory, but the author, who "urges the student to regard samples of rock as more than just uninteresting specimens," might have strengthened his appeal by including some brief digressions on petrogenesis and descriptions of a few classic igneous complexes.

T. D.

PETROLEUM PRODUCTION: Vol. III, Oil Production by Water. By Park J. Jones. Pp. vii + 271, 9 × 6. (New York: Reinhold Publishing Corporation; London: Chapman & Hall, Limited, 1947.) Price 30s.

This is the third volume of a series of works by the author on petroleum production. The two preceding volumes, published in 1946, are entitled *Mechanics of Production: Oil, Condensate, Natural Gas* and *The Optimum Rate of Production*.

The book under review considers the production of oil by means of water injection. The subject-matter is divided into two parts, of which Part I, headed "Foundations," contains six chapters with the following titles: oil ahead of water, oil production by expansion, well-producing capacity, injection of water, the optima for reservoirs, and migration of oil. Part II, which is entitled "Applications," consists of chapters on radial reservoirs, two pay intervals, impermeable wedges, saturated oil, linear reservoirs, elongated reservoirs, and bottom water.

The text is burdened with formulae and equations, and the explanatory matter combines an extremely terse and sometimes over-condensed style with the technical language of the petroleum production engineer. The author adheres to this manner of writing even in the preface, which would be better termed a summary of the principal factors discussed in this volume. It follows that the book will doubtless present to the general reader the forbidding ap-

pearance of a textbook on hydro-mechanics, and that it will have little appeal outside the specialist circle for which, essentially, it appears to have been written.

The work has been well produced and is profusely illustrated by graphs and diagrams, of which there are 175 in all.

P. L. R.

REPORTS ON FUEL ECONOMY SINCE 1939: Finnish National Committee, pp. 4, $9\frac{1}{2} \times 6\frac{1}{4}$, price 4*d.*; Comité Algérien [in French], pp. 15, $9\frac{1}{2} \times 6\frac{1}{4}$, price 1*s.*; Belgian National Committee, pp. 7, $9\frac{1}{2} \times 6$, price 6*d.*; Norwegian National Committee, pp. 12, $9\frac{1}{2} \times 6$, price 6*d.*; Portuguese National Committee, pp. 8, $9\frac{1}{2} \times 6$, price 6*d.*; Swiss National Committee, pp. 20, $9\frac{1}{2} \times 6$, price 1*s.*; Report for Hungary prepared by Professor L. de Verebélÿ and others, pp. 5, $9\frac{1}{2} \times 6\frac{1}{4}$, price 6*d.* (London: Central Office of the World Power Conference, 1947.)

The publication of these seven reports completes a set of 19, the remainder having been reviewed in preceding issues of this BULLETIN (1947, **45**, 82-83, 191-192 and 308-309).

The report of the Finnish National Committee is entirely statistical and lacks details upon the technical side of fuel economy.

The Algerian report, the only one of this series that has not been printed in English, covers all aspects of the subject extensively, and is a welcome addition to the brief comments on French overseas territory that appeared in the report of the French National Committee.

In Belgium the fuel situation was most acute during 1944 and 1945. The report for this country mentions the utilisation of "spriet," a kind of lignite found in the Campine, as a substitute fuel.

The Norwegian report is divided into two main sections, of which the first is devoted to hydro-electricity and the second deals with coal, coke, wood fuel and peat.

The report of the Portuguese National Committee provides a well-presented account of conditions in Portugal itself. Owing to insufficient information, no attempt is made to produce a detailed statement regarding the Portuguese colonies.

The Swiss report is of special interest in that it shows the effect of war-time conditions upon a country where hydro-electric power is the only important source of energy, and where electrification was already virtually complete in all cases in which it was economically practicable to use electricity in place of fuel.

The report for Hungary is in the form of a statistical narrative of the past changes and future plans with regard to production and consumption of fuel and power, but does not give particulars of the technical problems involved.

No bibliography is included in the Finnish, Algerian, Belgian and Hungarian reports, whereas the detailed bibliography in the Swiss report covers 11 pages and contains 150 references.

Although standardisation was attempted for the layout of the reports in this series, they nevertheless exhibit considerable variation in scope and comprehensiveness, a fact indicated by the comments in this and in the preceding reviews.

P. L. R.

INDUSTRIAL CARBON: ITS ELEMENTAL, ADSORPTIVE, AND MANUFACTURED FORMS. By C. L. Mantell, Ph.D. Second Edition, Second Printing. Pp. x + 472, 9 × 6. (New York, Toronto: D. Van Nostrand Company, Inc.; London: Macmillan & Company, Limited, 1947.) Price 42s.

The first edition of this book was reviewed in this BULLETIN, 1929, **27**, 438-9. It then comprised 410 pages, divided into 29 chapters, and gave a comprehensive summary of the uses, at that time, of elemental carbon. The present volume contains 472 pages, but only 25 chapters.

There has been much re-arrangement of the subject-matter and chapter headings, the very short chapter on battery and welding carbons in the first edition, for example, being now included in a new chapter on carbon specialities and resistors. Carbon refractories, which were formerly considered very briefly in a chapter on resistor carbon and carbon refractories, are now given more adequate treatment in a separate chapter. The subject of binding materials for electrodes, which was included in the first edition in the chapter on electrodes, has now been transferred to a new chapter on raw materials for carbon manufacture, and developments in the use of graphite in electronic tube anodes are dealt with in a chapter on that subject. The chapter on charcoal as fuel has been deleted, and a new and useful chapter on analytical and testing methods has been included.

There is some unevenness of treatment of different subjects, but this may perhaps be expected in a book in which a number of chapters are written by specialists in various branches. The subject of welding carbons, for example, about which much might be written, is dismissed in 12 lines, while brushes and electrodes are given 28 and 36 pages respectively.

The matter of references to published information is also uneven. The chapter on electrodes gives only two references, while that on gas adsorbents gives 79, and at the end of the chapter on brushes there is a bibliography of 61 references.

The book has been largely re-written and brought up to date. This revision is timely, as many developments in the use and manufacture of carbon and graphite products have taken place during the 19 years that have elapsed since the first edition was published. The present edition, like its predecessor, is an extremely useful treatise and summary of available information on the diverse uses of elemental carbon, and should be on the book-shelves of all who are interested in the industrial applications of this substance.

W. O. R. W.

THE SAMPLING AND ASSAY OF THE PRECIOUS METALS. By Ernest A. Smith, Assoc. R.S.M. Second Edition, Revised. Pp. xvi + 505, $8\frac{3}{4} \times 6$. (London: Charles Griffin and Company, Limited, 1947.) Price 42*s*.

Smith's "Assaying" has long been recognised as a standard textbook on the sampling and assaying of the precious metals; as, however, the first edition appeared 35 years ago, a revision now becomes very necessary and welcome.

In many respects precious metal assaying is an art rather than a science, and detailed practical instructions are necessary to enable even a skilled analytical chemist to obtain reliable results. Basically, the assayer's art has changed but little for many years now, and, as might therefore be expected, those portions of the book dealing with sampling and fire assaying have needed and have received the least revision. Chapters and sections have, with advantage, been re-arranged and their headings altered and put into bolder type both in the interest of clarity and in order to enhance the appearance of the book, but the very full working instructions given in the original edition have received only minor amendments.

Despite the fact that our knowledge of assaying processes is still incomplete, very few investigations have recently been undertaken in this field of work, so much so that the author's present account of cupellation in Chapter XI remains almost identical with that given in the first edition. Though copied verbatim from the first edition, the statement on page 151 is still true that the processes taking place are still not completely understood, although "it is to be hoped that, by the introduction of new methods of investigation, more exact knowledge respecting this most important of assay operations will soon be forthcoming."

Chapter XVI (Chapter VI in the first edition) dealing with the physical and chemical properties of gold and silver, has been extensively re-written and now includes methods for the determination of these metals in plating and other solutions. Chapter XVIII dealing with the assay of gold bullion has been extended by a description of W. B. Pollard's hydroquinone-o-toluidine volumetric method for the determination of gold, a short account of the applications of spectrographic analysis to the examination of precious metals and their alloys, and a summary of methods available for the determination of selenium and tellurium in gold bullion. A number of methods for the assay of industrial gold and silver alloys that have been published since the first edition are now included in Chapter XXI.

The analytical chemistry and the applications of the platinum group metals have developed considerably of recent years, and Chapters XXIII and XXIV dealing with these subjects have been largely re-written. The author acknowledges his indebtedness to Schoeller and Powell's *The Analysis of Minerals and Ores of the*

Rarer Elements for much of the information included in these chapters and he also gives a full account of the work in this field carried out and published by the staff of the United States Bureau of Standards.

Although the description and data for the I.M.M. series of sieves is given on p. 107, the British Standard series of test sieves is surprisingly not mentioned.

As stated in the preface, the book is primarily intended for students; the popularity of the first edition is, indeed, proof of its success in this direction. The revised edition should be even more useful, and may also be recommended as a reference book for the experienced assayer.

W. H. B.

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EMPIRE EDUCATIONAL FACILITIES

EXHIBITION GALLERIES, LANTERN SLIDES, FILMS, LECTURES, Etc.

Exhibition Galleries.—A great deal of useful work and planning was carried out during the second half of 1947, during which period also the Staff of the Exhibition Galleries was brought almost up to pre-war strength by the appointment of a new Guide Lecturer and three Exhibition Officers.

Stamp Exhibition.—The British Philatelic Society's 1947 Exhibition was held in the Exhibition Pavilion in October and November 1947 and attracted the usual large attendance.

Attendance.—The total number of people visiting the Galleries showed only a slight increase compared with the second half of 1946, but this was undoubtedly due to the fact that the British Isles enjoyed one of the finest and warmest summers for very many years. Outdoor recreations and pursuits attracted many thousands who would otherwise have visited the Imperial Institute.

The number of organised parties, however, increased substantially. Figures for the two comparable periods were:

July to December 1946,	77,775	including	337	parties
,, ,, ,, 1947,	80,717	,,	447	,,
Increase	2,942		100	

More than 95 per cent. of the 447 organised parties were school classes and classes from Teachers' Training Colleges, whose increasing interest in the educational facilities available in the Exhibition Galleries is very gratifying. The attendances for the whole of 1947 numbered 138,964, including 819 organised parties.

Gift from Her Majesty Queen Mary.—In July 1947, shortly after the return of the Royal Family from their memorable tour of the Union of South Africa, Her Majesty Queen Mary generously presented the Institute with a native dress and collar, both heavily decorated with bead-work, which had been presented during the tour to Her Royal Highness The Princess Elizabeth.

Gifts from His Royal Highness the Duke of Gloucester.—In December 1947 His Royal Highness the Duke of Gloucester presented to the Institute a casket of local minerals from the Northern Territory of Australia as well as two caskets made of ornamental Australian woods and containing illuminated addresses from the City of Brisbane and the State of Queensland. These had

been received by His Royal Highness on the conclusion of his term of office as Governor-General of the Commonwealth of Australia.

Other Gifts.—In August and September the Director of the Institute made a personal gift to the Galleries of two hand-carved wooden figures of typical Canadian fishermen, three Chinese carved wooden figures, a metal reproduction of an Indian paddy bird, and an East African diver bird carved in Kenya out of buffalo horn.

Other much appreciated gifts were: a Nigerian gown dyed with indigo and decorated with crochet-work from Lady Emmott; a large hand-made wooden Solomon Islands comb from Captain C. R. Cox; two model bark canoes and a water-carrier from Arnhem Land in Northern Australia and three carved and decorated New Guinea food-bowls from Miss Thomson, sister of Mr. Donald F. Thomson, O.B.E., D.Sc., of Melbourne; and a dozen or more albums of West African photographs taken over a period of years by Mr. Cecil Firmin, of the Colonial Service, and presented by his sister, Mrs. Fawcett, of Richmond, Yorkshire.

Cross References.—Two useful systems of cross-reference labels have been adopted in the Galleries. Against each of the many small exhibits of products which are of only minor importance in one country there is now a label of a distinctive colour which tells the visitor in which Court he will find the full story of that particular product; cotton, for example, is of major importance in India and the Sudan and in their Courts its story is told in detail from the growing crop to the finished fabric. All other exhibits of cotton therefore now carry a reference to the Indian or Sudan court.

The other series of labels covers those important products or industries which are illustrated in the Galleries by both a diorama and a showcase. Visitors do not always connect the one with the other and may therefore only see half the story. Cross-reference labels now link the two together.

New Exhibits and Improvements.—*India.*—The interior fluorescent lighting of the wall-cases in the India Court was half completed by the end of 1947 and three of the seven friezes, executed by Mr. and Mrs. Roop Krishna and depicting scenes complementary to the contents of the show-cases, were also in position above the cases.

A fruiting spray of *Hydnocarpus Wightiana*, the oil from the seeds of which is useful in the treatment of leprosy, has been modelled by Mr. A. J. Carter and placed in the drug case in the India Court. This will ultimately form part of a larger exhibit to be arranged in conjunction with the British Empire Leprosy Relief Association.

The black-and-white and sepia transparencies in the windows of the India Court have now been coloured by Mr. A. J. Carter and look very much more attractive than before.

These improvements formed part of a general scheme of re-decoration and renewal of exhibits on new and up-to-date lines, which had been approved last year by the High Commissioner for India.

East Africa.—A particularly interesting set of twelve photographs taken in the Budongo Forest of Uganda and received through Dr. J. Eggeling, Conservator of Forests, has been placed in the East African Court. These illustrate the growing, felling, transport, and milling of mahogany, iroko or African teak, and ironwood.

The increased public interest in Empire tobaccos arising from the need to save gold and dollars is reflected by a new diorama, the work of Mr. A. J. Carter, illustrating the growing and curing of tobacco in Nyasaland, where this is a crop of major importance.

Southern Rhodesia.—Both the maize and tobacco dioramas have been repainted, the cost being defrayed out of a sum of £575 granted by the Government of Southern Rhodesia for extensive improvements to the Court.

West Africa.—Many interesting Nigerian photographs have been received through the good offices of Mr. A. E. Bull, Director of the West African Photographic Service. They deal with agriculture and farming, including the growing of cotton, sugar, cocoa, and rice, the breeding of pigs, soil erosion, and the Oyo Farm School where young West Africans are taught modern methods of farming and stock-raising.

Cyprus.—Samples of cotton curtain material and pottery-ware have been received from the island of Cyprus.

Gibraltar.—A photograph taken during the famous "Ceremony of the Keys" and a brief account of the ceremony itself and of its origin during the Great Siege have been added to the Gibraltar Court just above the case containing replicas of the Keys.

A special panel nearby has been devoted to a selection of recent photographs taken in and around the Rock.

Canada.—A bronze statuette of Henry Hudson, the famous navigator, has been installed in the Canadian Court and faces the visitor entering this Court from the South Gallery. It was the gift of the Hudson's Bay Company and was executed by Mr. Herbert Cawood.

Western Pacific.—A large number of excellent photographs has been received from the Public Relations Officer at Suva, Fiji. Gold-mining, the sugar industry, education, medical services, housing, and recreation are the subjects dealt with. As a result the display relating to the sugar industry of the Fiji Islands has been completely rearranged and a new display covering the mining of gold will be completed when samples of ore come to hand. The other photographs have replaced some very old sepia prints on the pillars in the Colonial Annexe.

The case devoted to the island of Tonga has been greatly improved by the inclusion of a very interesting set of photographs from the same source, taken at the double wedding on June 10, 1947, of the two sons of Queen Salote Tubou, D.B.E., the Ruler of the Island.

Several photographs and other material relating to the phosphate

deposits of Ocean Island and Nauru have been received through the courtesy of the International Superphosphate Manufacturers' Association. The photographs have been incorporated in the existing phosphate exhibit and will ultimately be used in a very much larger display now being planned in conjunction with the British Phosphate Commissioners.

British Malaya.—The Dunlop Rubber Company has very kindly supplied a larger and more modern section of a built-up motor tyre to replace a smaller one which had become obsolete.

Empire Lantern Slide and Film Strip Library.—During the six months, July-December 1947, 20,380 lantern slides and 239 film strips have been issued to schools and lecturers in the United Kingdom. The details of the issue of lantern slides are as follows:

	July	Aug.	Sept.	Oct.	Nov.	Dec.
Canada	120	—	720	180	720	300
Australia	240	—	240	720	780	240
New Zealand	120	—	180	300	300	180
South Africa	360	60	180	540	180	120
India	180	—	240	840	1,440	720
Burma	60	—	—	240	300	240
Colonial Empire	1,360	120	840	2,040	2,520	900
Products of the Colonial Empire	60	60	60	300	180	60
General Tours	120	—	—	180	60	60
History	—	—	60	240	60	60
	2,620	240	2,520	5,580	6,540	2,880

Mr. C. Whybrow, M.A., LL.B., Senior Education Officer, Tanganyika Territory, has written a talk, and provided most of the pictures, on "Life and Travel in Tanganyika." He first describes the chief physical features of the country and its climate and the conditions of life these impose on the people. The children start to help their parents at a very early age, and school life is generally subsidiary to the need to fetch water, herd cattle, build contour ridges to prevent soil erosion, frighten away locusts and generally help in the cultivation and harvesting of crops. All these activities are illustrated, together with pictures of a school farm, the infants' school and the primary school. Mr. Whybrow then describes the animals of the country, the towns and villages and some of the African customs, ending with a picture of Mount Kilimanjaro.

Central Film Library.—It will be seen from the table given below that films circulated by the Library during the second half of 1947 show an appreciable increase over those for the corresponding months of 1946. The most noticeable increase is of Central Office of Information films for the October-December quarter, where there is a rise of no less than 5,690, or 36 per cent., over the 1946 figures for the same period.

It should be explained that this predominant rise in one section

of the Library is accounted for by the much greater number of new films brought into circulation by the Central Office of Information. The Empire Library is made up principally of silent films depicting life in the Dominions and Colonies, and, although these films continue to be in heavy demand by Library users, mostly schools, it is almost impossible to supplement them with new material. As negatives become worn out reproduction of existing films ceases to be possible, with the result that the Empire Library, although distributing to capacity, is no longer able to improve on its circulation figures.

The Imperial Institute, with the co-operation of the Colonial Office and the Dominions Office in London, hopes that it may soon be possible to increase greatly the number of 16 mm. silent films in the Central Film Library.

TABLE SHOWING NUMBER OF FILMS CIRCULATED DURING THE HALF-YEAR JULY–DECEMBER

	1947.				1946.			
	Empire.	G.P.O.	C.O.I.	Total.	Empire.	G.P.O.	C.O.I.	Total.
July . . .	1,837	354	3,346	5,537	1,857	344	3,033	5,234
August . .	315	118	1,759	2,192	430	113	1,706	2,249
September .	1,631	312	3,773	5,716	1,516	307	2,829	4,652
October . .	2,809	528	6,868	10,205	2,736	495	4,655	7,886
November . .	2,873	513	8,076	11,462	2,762	506	6,204	9,472
December . .	2,110	399	6,501	9,010	1,961	396	4,896	7,253
Total .	11,575	2,224	30,323	44,122	11,262	2,161	23,323	36,746

The circulation figures for the whole year totalled 92,840, compared with 81,550 for 1946, and it was noticeable that the increased demand was due largely to the many requests from new borrowers. Now that projectors are becoming available in greater numbers for schools and other organisations wishing to make use of films for educational and recreational purposes, the work of the Library grows accordingly, and with new applications coming in at the rate of 100-150 a week, it is likely to become increasingly difficult for the Library to keep pace with demand.

New Films.—The High Commissioner for the Union of South Africa has presented the Library with twelve 16 mm. sound prints of each of the following new productions:

Africa No. 4	A survey of Cape Town and the Cape Peninsula.
Africa No. 5	(1) The growing of pyrethrum in Kenya. (2) Work of the South African artist, Irma Stern.
Africa No. 6	(1) Work of the South African Institute of Locust Research. (2) Felling of giant trees.
Towards To-morrow . .	Improving the condition of the Cape coloured people of the Union of South Africa.
South Africa on Show . .	The Royal Tour in South Africa, 1947.
After Sixty Years . . .	The story of Johannesburg.

Among the remaining newly-acquired films of the Overseas Commonwealth are the following:

CANADA.	
New Homes for Beavers .	The restocking of the James Bay area with beavers from Algonquin Park.
Accidents Don't Happen—Handling Accidents Don't Happen—Falls	Two of a series on the avoidance of accidents in factories.
AUSTRALIA.	
Nature Unspoiled (35 mm. only)	The great plains of Central Australia.
The Story of the Trout . .	How Tasmanian rivers are regularly re-stocked with trout.
SOUTHERN RHODESIA.	
Southern Rhodesia—Is This Your Country? . .	The story of Southern Rhodesia and conditions of life there at the present time.

Empire Lectures to Schools.—In the last note on the scheme it was suggested that the Autumn Term (September to December 1947) would show a progressive increase in the number of lectures arranged. This forecast was justified and the ground lost in the early part of the year due to the change in the financial structure of the scheme was very largely regained. During this period 1,276 lectures were given as compared with 1,910 for the corresponding term in 1946. The prospects for the Spring Term 1948 are encouraging and there is good reason for hoping that the peak figure attained in 1946 (i.e. 4,044) will be reached again or even surpassed. To give 4,000 lectures to audiences exceeding half a million children each year can fairly be regarded as a contribution of no little value to the task of bringing a knowledge of the Commonwealth countries, both Dominions and Colonies, to the young people of the United Kingdom, particularly as this knowledge is presented in many cases by nationals of the countries described and in all cases by people who speak not only from a close acquaintance with the country, but also with a sympathy and understanding to which children naturally respond.

The move to secure the maximum participation by Local Education Authorities, of whom there are about 140 in England and Wales, in the operation of the scheme, has continued and the General Secretary has so far visited nearly 80 of them personally. It is hoped, as circumstances permit, to extend these personal contacts. By the end of 1947 about 50 authorities had responded favourably, 30 had declined, at least for the time being, and the remainder had not announced their decisions. In view of the difficult conditions, financial and administrative, under which the Local Authorities are at present working, this response cannot be regarded as unsatisfactory. Indeed, it can reasonably be expected that by the end of 1948 the schools in rather more than half the counties and county boroughs of England will be receiving lectures regularly term by term. It will be noted that the very important feature of continuity is thus being secured.

In implementing the policy which organised and animates the scheme, as it concerns co-operation with the local Education Departments and day-to-day operation amongst the schools, the practical assistance of H.M. Inspectors by advice and in other ways has been invaluable. A tribute should also be paid to the Director of Information Services at the Colonial Office, with whom close contact is maintained and through whom the illustrative material and up-to-date information needed by the lecturers are made available to them.

Colonial Visitors.—The following is a list of officers on leave from the Colonial Empire who have visited the Institute during the six months ending December 1947:

JULY

J. A. ALLAN, Agricultural Officer, Cyprus.
J. P. ATTENBOROUGH, O.B.E., Deputy Director of Education, Palestine.
W. E. BASSETT, Agricultural Superintendent, Montserrat.
H. D. L. CORBY, Agricultural Officer, Nigeria.
SIR FRANKLIN C. GIMSON, K.C.M.G., Governor, Singapore.
H. W. HALL, Lecturer in Handicraft, Trinidad.
K. T. HARTLEY, Senior Agricultural Chemist, Nigeria.
SIR HERBERT HENNIKER-HEATON, K.C.M.G., Governor, Falkland Is.
Dr. F. T. INGHAM, Director, Geological Survey Department, Malaya.
H. G. KEITH, Conservator of Forests, North Borneo.
D. F. MACPHERSON, Senior Veterinary Officer, Kenya.
K. C. MURRAY, Education Officer, Nigeria.
A. E. POUND, Director of Agriculture, Seychelles.
Dr. C. RAEBURN, Director, Geological Survey, Nigeria.
Miss C. E. RENTON, Education Officer, Malaya.
S. H. SHAW, Geologist, Palestine.
H. P. SMART, Senior Agricultural Officer, Tanganyika Territory.
R. C. S. STANLEY, C.M.G., O.B.E., Colonial Secretary, Gibraltar.
S. STOCK, Geologist, Somaliland.
Miss C. M. WALKER, Principal, Government Girls' School, Aden.
S. H. WIMBUSH, Assistant Conservator of Forests, Kenya.

AUGUST

P. D. FLETCHER, Political Officer, Aden.
W. GRASON, Headmaster, Grammar School, Dominica.
T. H. JACKSON, Assistant Agricultural Officer, Kenya.
Miss E. MARSH, Education Officer, Palestine.
R. O. ROBERTS, Chemist and Petrologist, Uganda.
I. SIBSON, Agricultural Officer, Gold Coast.
N. F. TUCKER, Master, Education Department, Hong Kong.
R. R. WATERER, Conservator of Forests, Cyprus.

SEPTEMBER

A. F. BULL, Education Officer, Kenya.
E. A. H. ELLIS, Education Department, Malaya.
J. GORDON, Agricultural Officer, Gold Coast.
T. HIRST, Director of Geological Survey, Gold Coast.
H. MACLUSKIE, Senior Agricultural Officer, Sierra Leone.
M. PIERROT, Education Officer, Mauritius.
G. VIGNE, Conservator of Forests, Gold Coast.
R. O. WILLIAMS, Director of Agriculture, Zanzibar.

OCTOBER

W. J. BADCOCK, Senior Agricultural Officer, British Solomon Islands.
A. W. M. BREW, Conservator of Forests, Northern Rhodesia.
G. S. BROWN, Assistant Conservator of Forests, North Borneo.
A. J. CARPENTER, Education Officer, Nigeria.

C. W. DAWSON, Chief Secretary, Sarawak.
C. W. L. FISHLOCK, Senior Agricultural Officer, Uganda.
C. G. G. GILBERT, M.C., Director of Education, Bermuda.
J. McDONALD, Director of Agriculture, Cyprus.
J. C. MUIR, O.B.E., Director of Agriculture, Trinidad.
H. W. C. NEWLANDS, Veterinary Officer, Tanganyika Territory.
J. SANDERSON, Inspector of Mines, Federated Malay States.
M. F. H. SELBY, Agricultural Officer, Nyasaland.
J. V. TAYLOR, Education Officer, Kenya.
F. W. THOMPSON, Master, Achimota College, Gold Coast.
C. WHYBROW, Senior Education Officer, Tanganyika Territory.
P. H. WINTER, Architect, P.W.D., Palestine.

NOVEMBER

Dr. M. F. FRENCH, Controller of Hides, Skins and Leather for East Africa.
R. HUNTER, Education Officer, Kenya.
E. H. JAQUES, Geologist, Nigeria.
S. E. JOHNSON, Resident Commissioner, Nigeria.
SIR GILBERT M. RENNIE, C.M.G., M.C., Governor-Designate, N. Rhodesia.
D. B. ROBERTS, Education Officer, N. Rhodesia.
W. N. SCOTT, Agricultural Officer, Malaya.
P. J. SHEEHY, Veterinary Officer, N. Rhodesia.
J. W. SMETHURST, Senior Education Officer, Tanganyika Territory.
R. J. M. SWYNNERTON, Agricultural Officer, Tanganyika Territory.
J. M. WINTERBOTTOM, Education Officer, N. Rhodesia.

DECEMBER

D. R. N. BROWN, Agricultural Officer, Uganda.
C. S. T. COLBY, C.M.G., Governor-Designate, Nyasaland.
R. A. McLAREN DAVIDSON, Director of Education, Nigeria.
A. C. FRITH, Assistant Conservator of Forests, Sierra Leone.
M. W. GIBBON, Agricultural Officer, Nigeria.
Miss E. F. GORING, Principal, European Education, N. Rhodesia.
E. C. HICKS, Senior Education Officer, Malaya.
Dr. A. R. LOWE, Principal Research Officer, Ceylon.
M. LUNAN, Agricultural Officer, Tanganyika Territory.
Rev. D. M. ROBERTSON, Principal Education Officer, N. Rhodesia.
R. K. TREMLETT, Agricultural Officer, Uganda.

All Dominion and Colonial Officers, as well as private residents from the Commonwealth overseas, who may be visiting London, are cordially invited to come to the Institute to see the Exhibition Galleries and to discuss with the Director and his staff, scientific, technical and educational problems in which they may be interested.

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Scientific names and titles of books are printed in italics and personal names in capitals